Executive Summary

In 2001, the South Carolina Department of Health and Environmental Control (DHEC) Environmental Surveillance and Oversight Program (ESOP) monitored all environmental media for impacts from the Savannah River Site (SRS) and compared data with the SRS monitoring program. Samples from groundwater, surface water, air, milk, soils, sediments, drinking water, game animals, fish and vegetation were collected and evaluated for both radiological and non-radiological contaminants. Monitoring results indicate that the SRS continues to impact the environment in several media, but the majority of the contamination remains on site. The levels of contaminants off site remain low and in some cases are decreasing. The primary media impacted are fish, game, air, surface water and groundwater. These media show higher levels of contamination on or adjacent to the site than levels detected in background monitoring sites. With the exception of some fish and soils data, comparisons between the ESOP and SRS monitoring programs were favorable and within the same order of magnitude. Most of the disparity in results could be attributed to natural variation in the media being compared or differences in sample locations.

Tritium continues to be the major contaminant being released to the environment. The main sources for tritium releases to surface water and groundwater are the Effluent Treatment Facility (ETF), and groundwater plumes originating from reactor areas and the Old Radiological Waste Burial Ground. Primary air releases are from the canyons, fugitive source and releases from the tritium replacement facility.

Monitoring and data comparisons will continue to be the primary vehicles for evaluating environmental impacts from the SRS. In addition to monitoring, the ESOP will be evaluating the SRS monitoring programs for effectiveness in detecting, identifying and quantifying contaminants being released by the site. As new missions and facilities are added the need for an active environmental surveillance program will continue. As facilities are removed or placed under institutional controls through the site clean up program, the need for verifying the effectiveness of these controls will also be a prime responsibility for an independent monitoring program.

For 2002 the ESOP will continue it's monitoring program and begin work on a critical pathway project to identify the primary contaminants and pathways of environmental transport and exposure. The ESOP will also be participating in a variety of outreach activities, initiating an edible vegetation project, and will seek to increase the number of colocated sample sites to improve opportunities for data comparison.

Introduction

ESOP maintains an independent surveillance program to supplement Department of Energy - Savannah River Site (DOE-SR) monitoring activities, and evaluate the effects of the SRS on public health and the environment. To assist in this mission, the ESOP independently evaluates the SRS non-regulatory environmental monitoring programs through an established multi-media network on and around the Site. The environmental monitoring data generated provides direct information about the concentrations of radionuclides in the air, water, vegetation, and foods near the Site.

ESOP uses the information gathered from these efforts to determine if the DOE-SR activities are protective of the public health and the environment. In addition, this information helps the ESOP support emergency response activities in the event of an unplanned release of radioactive materials; educate the public on monitoring activities around the SRS; and provide recommendations to the DOE for improving their environmental monitoring programs.

The ESOP environmental surveillance network includes: determining Radiological Atmospheric Quality Adjacent to SRS; monitoring Groundwater Quality adjacent to the SRS; Drinking Water Quality Monitoring; Radiological Surface Water and Sediment Surveillance; Non-Radiological Sediment and Surface Water Quality Monitoring; Radiological Surveillance of Surface Soils On and Adjacent to the SRS; Radiological Monitoring of Terrestrial Vegetation On and Adjacent to SRS; Radiological Monitoring of Dairy Milk; Radiological Monitoring of Fish in the Savannah River; Game Animal Monitoring Adjacent to SRS; Oversight Monitoring and Support Activities.

The implementation of radiological and non-radiological surveillance monitoring by ESOP six years ago has resulted in a significant increase in the understanding of the concentrations and movement of radioactive contaminants in the environment on and around the SRS. The knowledge gained aids in tracking releases from Site facilities, identifying pathways for potential exposure and coordinating with emergency responders for more effective emergency planning. ESOP is also actively involved in field oversight projects to verify the validity and effectiveness of monitoring activities at Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) sites. Additional projects are being considered to provide information for new proposed SRS facilities and to fill data gaps and evaluate other SRS non-regulatory monitoring programs. This improvement in monitoring capability underscores the commitment by the DHEC to fulfill its mission while reinforcing the DOE's commitment to improving open communication and cooperation with host states.

This 2001 ESOP Data Report provides a summary of the ESOP environmental monitoring results generated during the 2001 calendar year. The data and information presented are in accordance with the ESOP's Standard Operating Procedures and project monitoring plans. Copies of environmental reports may be obtained by contacting:

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Glossary

ASD	Analytical Services Division
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
Cs-137	Cesium-137
DHEC	South Carolina Department of Health and Environmental Control
DOE	US Department of Energy
DOE-SR	US Department of Energy at Savannah River Site
ECOD	Early Construction or Demolition
EPA	US Environmental Protection Agency
ESOP	Environmental Surveillance and Oversight Program
ETF	Effluent Treatment Facility
FFA	Federal Facilities Agreement
GIS	Geographic Information System
ICRP-30	International Commission on Radiological Protection
LLD	Lower Limit of Detection
LSD	Lower Savannah District
MCL	Maximum Contamination Level
MDA	Minimum Detectable Activity
NPDES	National Pollutant Discharge Elimination System
PRG	Preliminary Remediation Goal
REMD	Radiological Environmental Monitoring Division
SRS	Savannah River Site
TCLP	Toxicity Characteristic Leaching Procedure
TLD	Thermoluminescent Dosimeter
TSP	Total Suspended Particulates

Units of Measurement

g	**gram**
L	**Liter**
mrem	**millirem**
pCi	**picocurie**

ESOP routinely measures atmospheric radionuclide concentrations associated with the SRS to identify trends or elevations of radiological activities. Radiological atmospheric monitoring sites (**Map 1**) are located to provide spatial coverage of the project area where public exposure could occur.

Air monitoring capabilities in 2001 included air monitoring stations with capacity for sample collection of glass fiber filters, precipitation, silica gel columns, and thermoluminescent dosimeters (TLDs). The glass fiber filters were used to collect total suspended particulates (TSP). Particulates were screened weekly for gross alpha and gross beta. January, February, and March glass fiber filters were composited and analyzed for selected isotopes. Precipitation, when present, was sampled and analyzed monthly for tritium. Silica gel distillates of atmospheric moisture were analyzed every other week for tritium. TLDs were collected and analyzed every three months for ambient beta/gamma levels.

All DHEC data collected substantiated historically reported DOE-SR values for radionuclides in the ambient environment at the SRS boundary.

In general, average DHEC atmospheric radiological monitoring results (**Figures 1-3**) were lower than the DOE-SR reported average values, although within the same order-of-magnitude. One possible explanation for the difference in values is that some ESOP "perimeter" monitoring locations are located in adjacent population centers, approximately two miles from the SRS boundary, but included as "perimeter" monitoring locations to increase the number of comparable data points with DOE-SR boundary data.

In summary, no Environmental Protection Agency air standards were exceeded at the monitored locations and there were no significant elevations of radiological pollutant concentrations associated with SRS operations. ESOP sampling results (**Appendix A**) by DHEC indicate that SRS activities did have a measurable impact for tritium, but an insignificant impact on local air quality.

Figure 1. Average Gross Beta for TSP at the SRS Perimeter

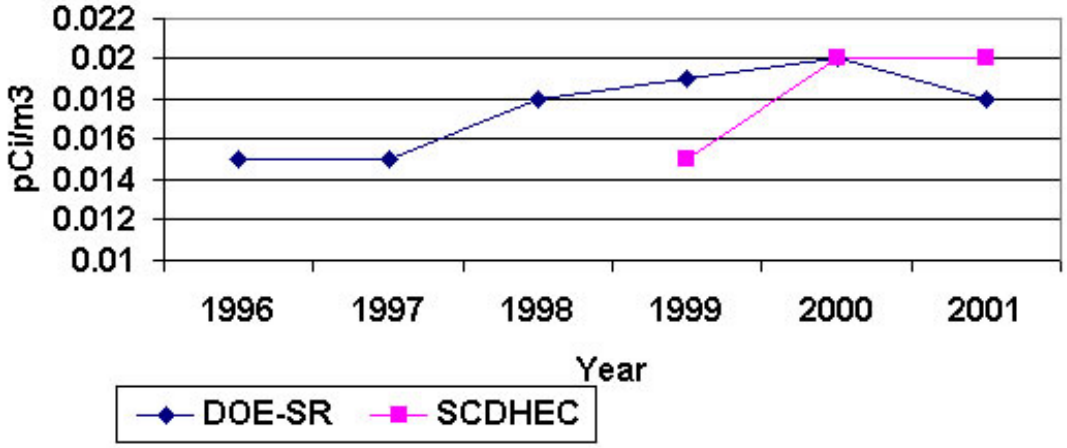


Figure 2. Average Ambient Beta/Gamma at the SRS Perimeter

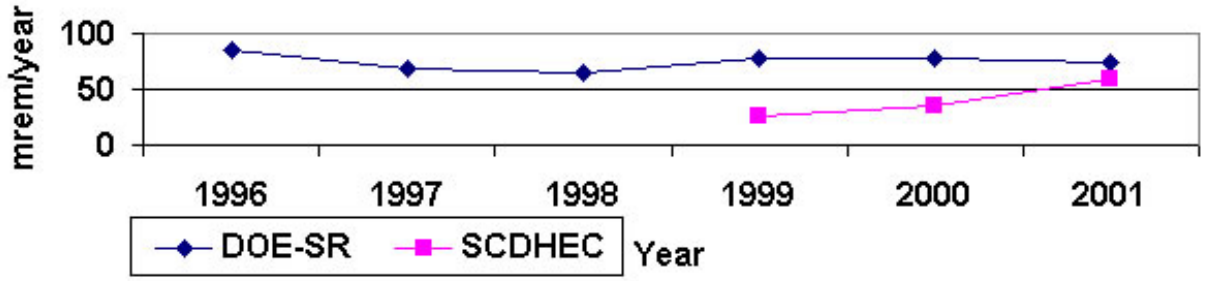
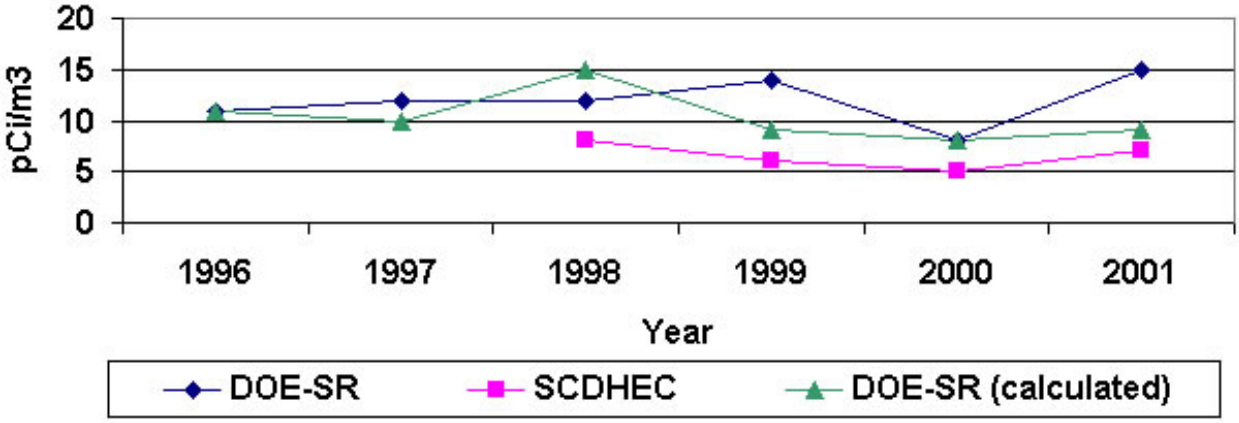
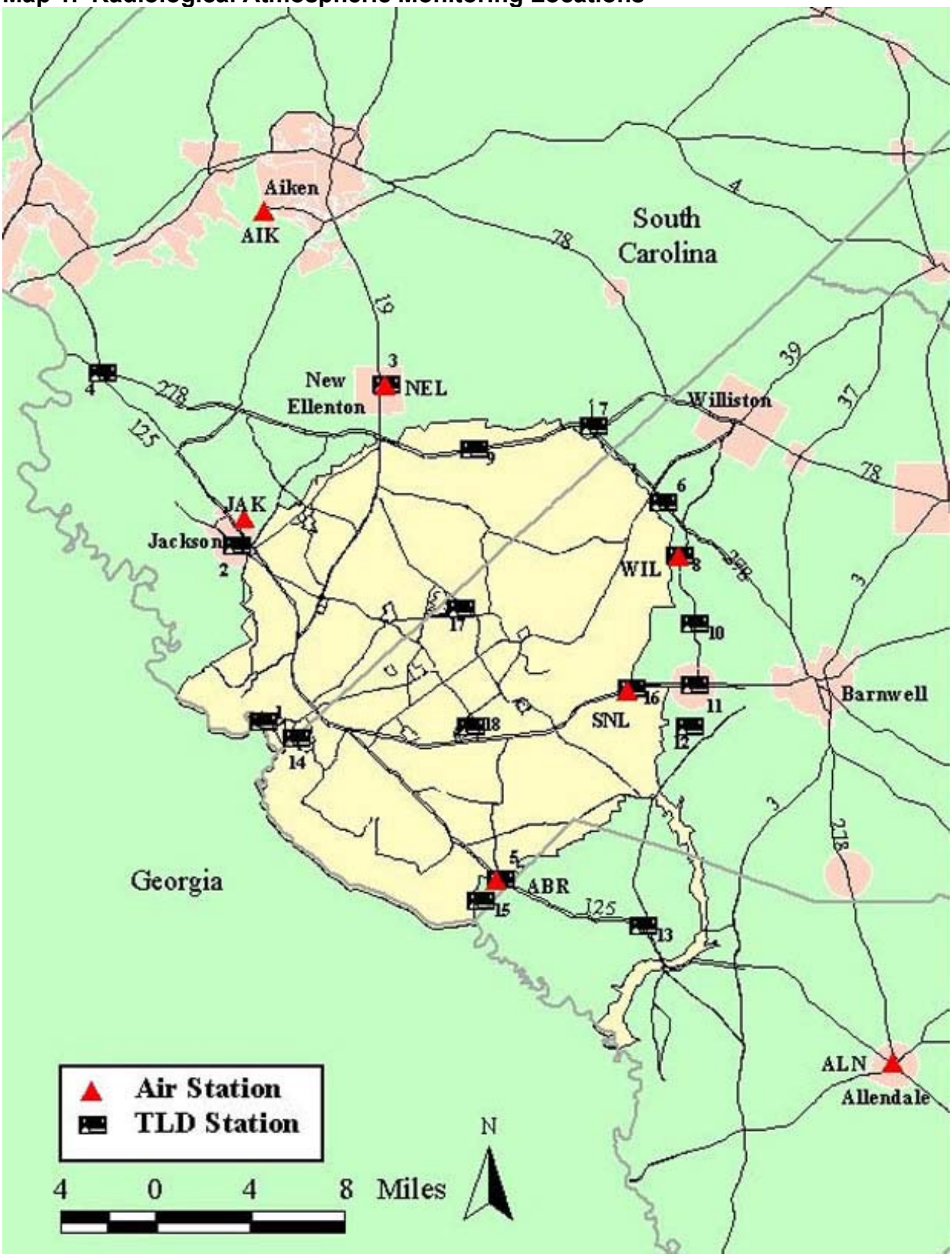


Figure 3. Average Atmospheric Tritium at the SRS Perimeter



Map 1. Radiological Atmospheric Monitoring Locations



Ambient Groundwater Quality Adjacent to SRS

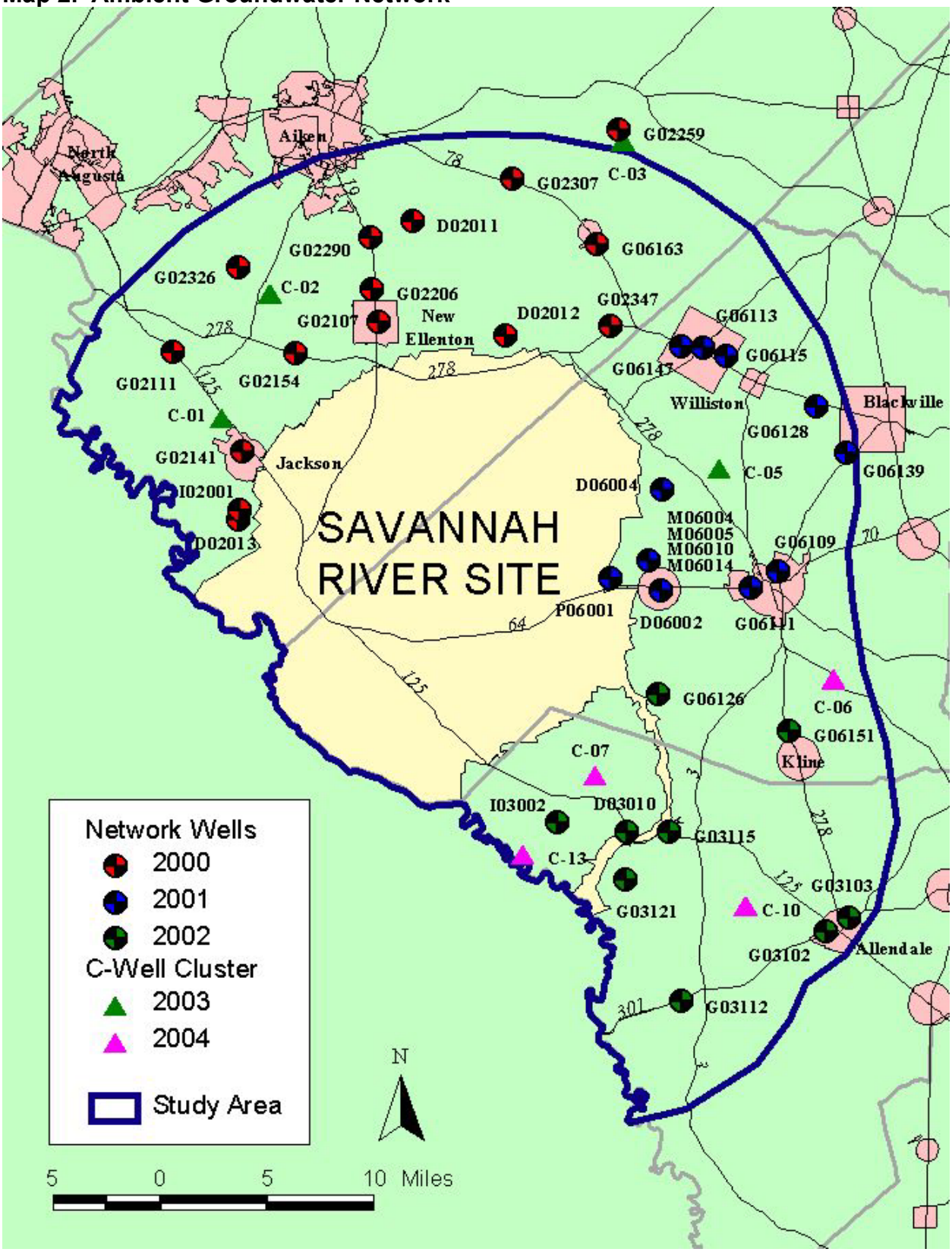
ESOP evaluates ambient groundwater quality around SRS in an effort to develop background water quality information and determine if contaminants have migrated off SRS. The ESOP Ambient Groundwater Monitoring Network ("Network") is comprised of groundwater wells owned by various government agencies and members of the public.

The project objectives were to evaluate groundwater quality adjacent to SRS, compare results with historical data, identify any off-site contaminant migration, and expand current ambient water quality databases. The study area includes SRS and a 10-mile perimeter from the site boundary in South Carolina. ESOP evaluated five aquifer zones within the study area from the shallow water table to confined aquifers more than 1200 feet deep. The Network wells are sampled on a five-year cycle. Twenty-four wells from the northwestern and eastern side of the study area were sampled in 2001 **(Map 2)**. ESOP analyzed filtered and non-filtered ground water for basic water quality parameters, metals, tritium, gamma-emitting, gross alpha, non-volatile beta, and naturally occurring radioisotopes (e.g., radium 226/228, total uranium, etc.).

Based on a review of the analytical data **(Appendix B)**, lead, gross alpha, and radium 226/228, contaminants that do not appear to be associated with SRS activities, were present in a few of the network wells. The United States Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for lead was exceeded in one well above the 15 μg/L "action level." The lead content in this well is most likely due to well construction material or geologic formation chemistry. Samples retrieved by the well owner from the drinking water systems associated with this well did not indicate lead contamination above the "action level." One monitoring well exceeded the EPA MCL of 15 pCi/L for gross alpha. The radioisotope content in this well is most likely naturally occurring but a speciation was not performed. Two monitoring wells exceeded the EPA MCL for radium 226/228 above the 5 pCi/L combined standard. The radioisotope content in this well is most likely naturally occurring.

ESOP plans to continue this monitoring project in 2002 by sampling another section of the well Network. Because naturally occurring radioisotopes have been recently found in some public supply wells in this part of the state, it is recommended that naturally occurring radioisotopes continue to be evaluated throughout the ESOP study area. In addition, data gaps in the network should be addressed through the sampling of wells on SRS.

Map 2. Ambient Groundwater Network



Drinking Water Quality Monitoring

The ESOP Drinking Water Monitoring Project evaluates drinking water quality to assure the public that man-made radiological constituents above regulatory limits have not impacted municipal drinking water systems adjacent to SRS. ESOP collects raw water composite samples from water treatment plants that use the lower reaches of the Savannah River as source water; and quarterly grab samples from selected municipal and large community drinking water systems within 30 miles of SRS. ESOP analyzed samples for gross alpha, nonvolatile beta, gamma-emitting radionuclides, and tritium.

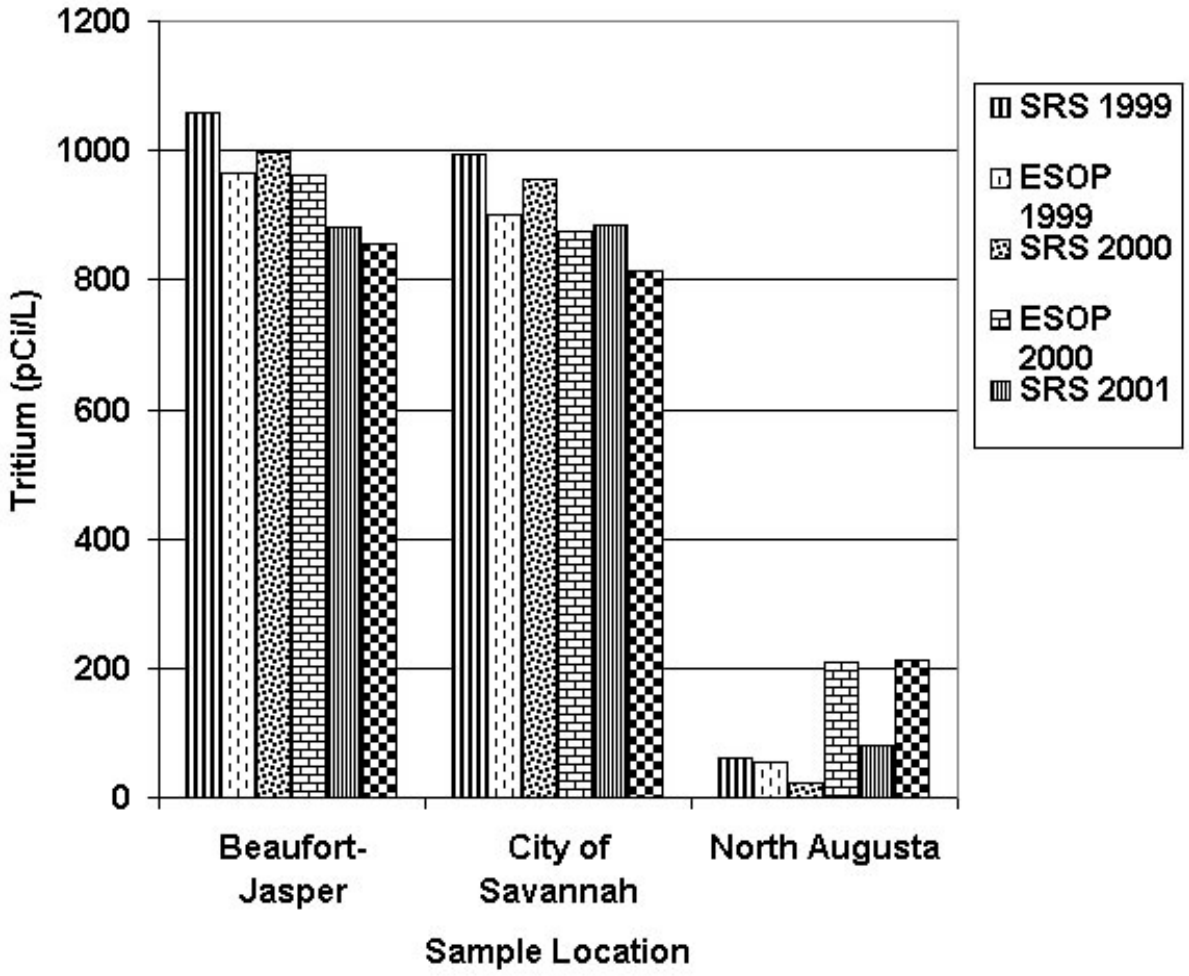
The DHEC monitors community/municipal water systems for various contaminants including radionuclides. DHEC requires monitoring for man-made and naturally occurring radionuclides for a minimum of four consecutive quarters during system start-up. Monitoring continues quarterly if the running average exceeds the EPA MCL. Monitoring is reduced to once every four years if activities are below the MCL. ESOP supplements this monitoring with quarterly monitoring of selected systems in the vicinity of SRS and by collecting monthly composites of raw surface water from water treatment plants that use the lower reaches of the Savannah River.

All public water systems in the ESOP study area (**Map 3**) were identified using the DHEC Geographical Information System (GIS). Nearly all of the municipal and large community systems within the study area were selected for sampling. Of the systems selected, 17 were groundwater fed and three were surface water fed systems. These systems serve approximately 225,000 customers with approximately 96,000 receiving their water from groundwater sources. The Lower Savannah District (LSD) Laboratory analyzed the samples for tritium while the DHEC Radiological Environmental Monitoring Division (REMD)conducted gamma spectroscopy, gross alpha, and gross nonvolatile beta analyses.

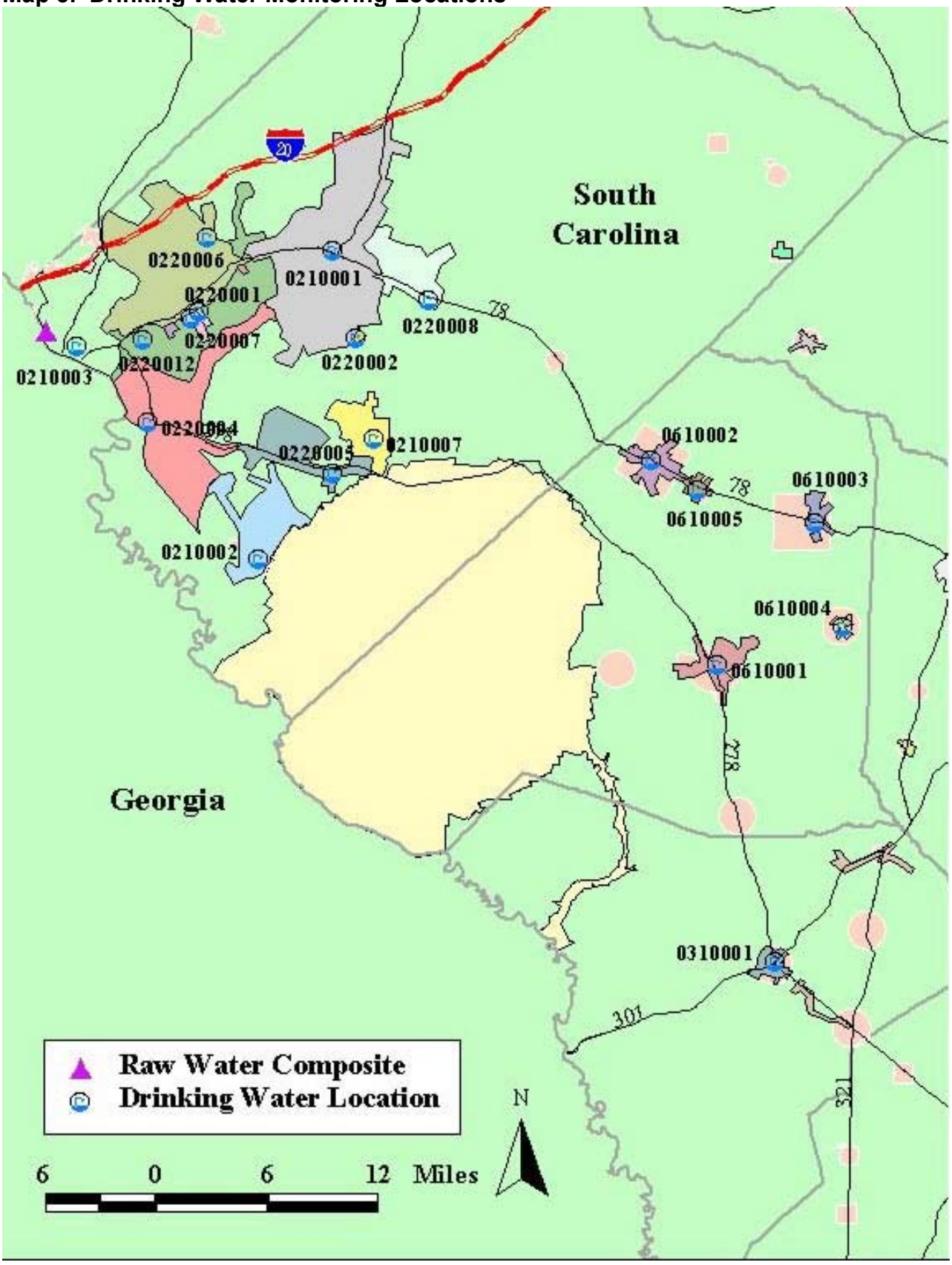
Tritium continues to be the most abundant radionuclide detected in public drinking water supplies potentially impacted by SRS and Plant Vogtle. It was detected in both groundwater and surface water-fed systems. However, these tritium results were well below the 20,000 pCi/L MCL (**Figure 4**). ESOP tritium results are consistent with DOE-SR data generated (**Appendix C)** from three colocated systems Gross alpha, gross beta, and gamma-emitting radionuclides were not detected at activities above their respective MCLs.

Gamma-emitting radionuclides were not detected above the Minimum Detectable Activity (MDA). However due to source sampling results from the DHEC regulatory monitoring program, it appears that radium is becoming a growing concern in portions of the ESOP monitoring area. ESOP is addressing this by collecting reserve samples in some areas of the network. If the initial sample results have a gross alpha level above 15 pCi/L then the reserve will be sent to a contract lab for additional speciation. In addition, differences in monitoring locations (source sampling vs. distribution system sampling) will be investigated to determine the effects on radionuclide levels being detected by the ESOP.

Figure 4. Average Tritium Concentration in the Savannah River



Map 3. Drinking Water Monitoring Locations



Radiological Surface Water and Sediment Surveillance

The Radiological Surface Water and Sediment Project collects and analyzes surface water and sediments for radionuclides; compares results with historical SRS data; enhances surface water and sediment databases; characterizes trends of radionuclides in streams and sediments associated with SRS; and provides the public with independently generated data.

The radiological surface water and sediment sampling program consists of ambient sample locations and enhanced sample locations (**Map 4**). The program had a total of 13 surface water locations, five creek mouth locations, and 17 sediment locations. Surface water was collected three days per week from six enhanced surface water locations and once a week from the seven ambient locations. These samples are analyzed for tritium. In addition, surface water samples were collected into station specific monthly composites and were analyzed for gross alpha, gross beta, and gamma-emitting radionuclides. Stream water was also collected once a month from five Savannah River creek mouths. These river locations were monitored for tritium. Sediment samples were collected in May 2001 and analyzed for gross alpha, gross beta, and gamma-emitting radionuclides.

The enhanced surface water monitoring program provides downstream drinking water customers with advance notice of an SRS release. This early detection component consists of continuous monitoring of six SRS streams that flow to the Savannah River. ISCO® automatic samplers collect approximately 30 milliliters of stream water every 30 minutes. ESOP personnel collected these composite samples every Monday, Wednesday, and Friday. Samples were analyzed for tritium on the day of collection by the LSD laboratory. Results from the tritium analysis were used to project tritium activity in the Savannah River. There were no releases above expected activities or that warranted regulatory action during the 2001 sampling period. However, ESOP monitoring results continue to show that the SRS is having some impact on the environment.

ESOP detected tritium activity above background levels at all sample locations (**Figures 5-6**). Four Mile Creek and Pen Branch continue to present higher levels of tritium activity. The measured tritium activity in each of these streams is greater than the EPA MCL of 20,000 pCi/L for drinking water. Tritium activity from all surface water sampling stations ranged from <MDA to 202,133 pCi/L, with Four Mile Creek (SV-2045) having the highest activity. In addition, ESOP analysis of samples collected at the Four Mile Creek mouth (SV-2015) indicate that the public could be exposed to tritium activities greater than 20,000 pCi/L for drinking water at that location.

ESOP analysis of gross alpha activity ranged from <MDA to 13.00 pCi/L. Beaver Dam Creek (SV-2040) had the highest level of gross alpha activity. Gross beta activity ranged from <MDA to 7.87, with Four Mile Creek (SV-2039) having the highest measured gross beta activity. Cesium-137 (Cs-137) activity was detected in sediment samples collected in June 2002. The activities ranged from <MDA to 25.41 pCi/g, with Four Mile Creek (SV-2045) having the highest measured activity.

There are two project changes projected for 2002. The Highway 301 Bridge (SV-118) location will be added to the enhanced monitoring routine to increase sample frequency. Second, the Pen Branch (SV-2048) location at S.C. Highway 125 will be re-located to a stream station on SRS Road A-13 (SV-2047), enabling ESOP and DOE-SR to have colocated Pen Branch sampling

stations.

ESOP will continue collection and analysis of surface water and sediment on and adjacent to the SRS. ESOP monitoring will provide an improved understanding of radionuclide activities in the SRS surface waters and sediment and impart valuable information to human health exposure pathways.

Figure 5. Tritium Activity at Four Mile Creek 2000-2001

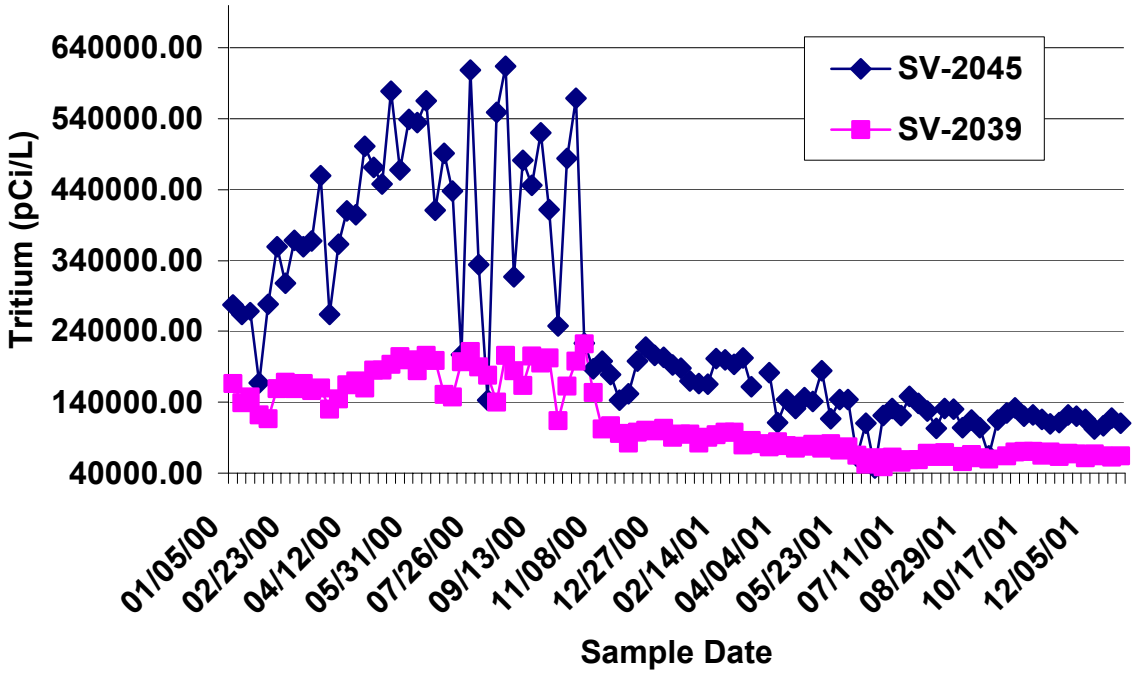
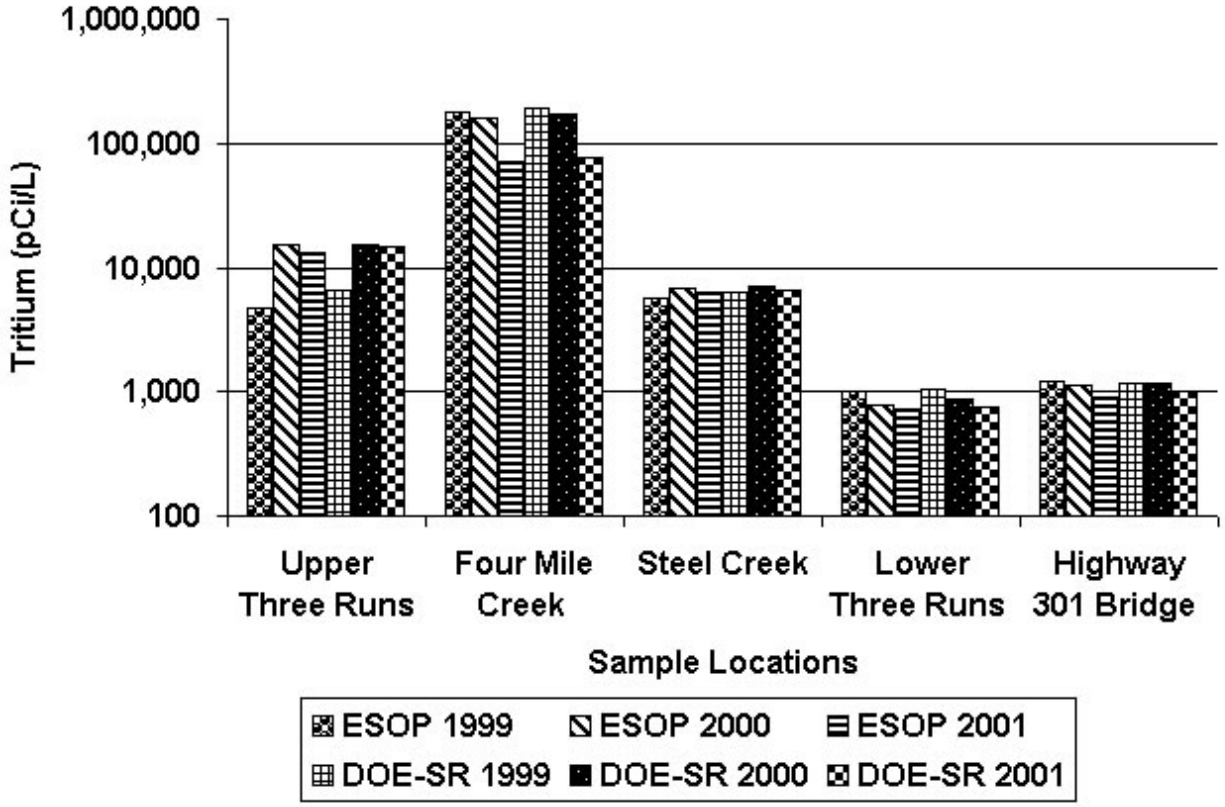
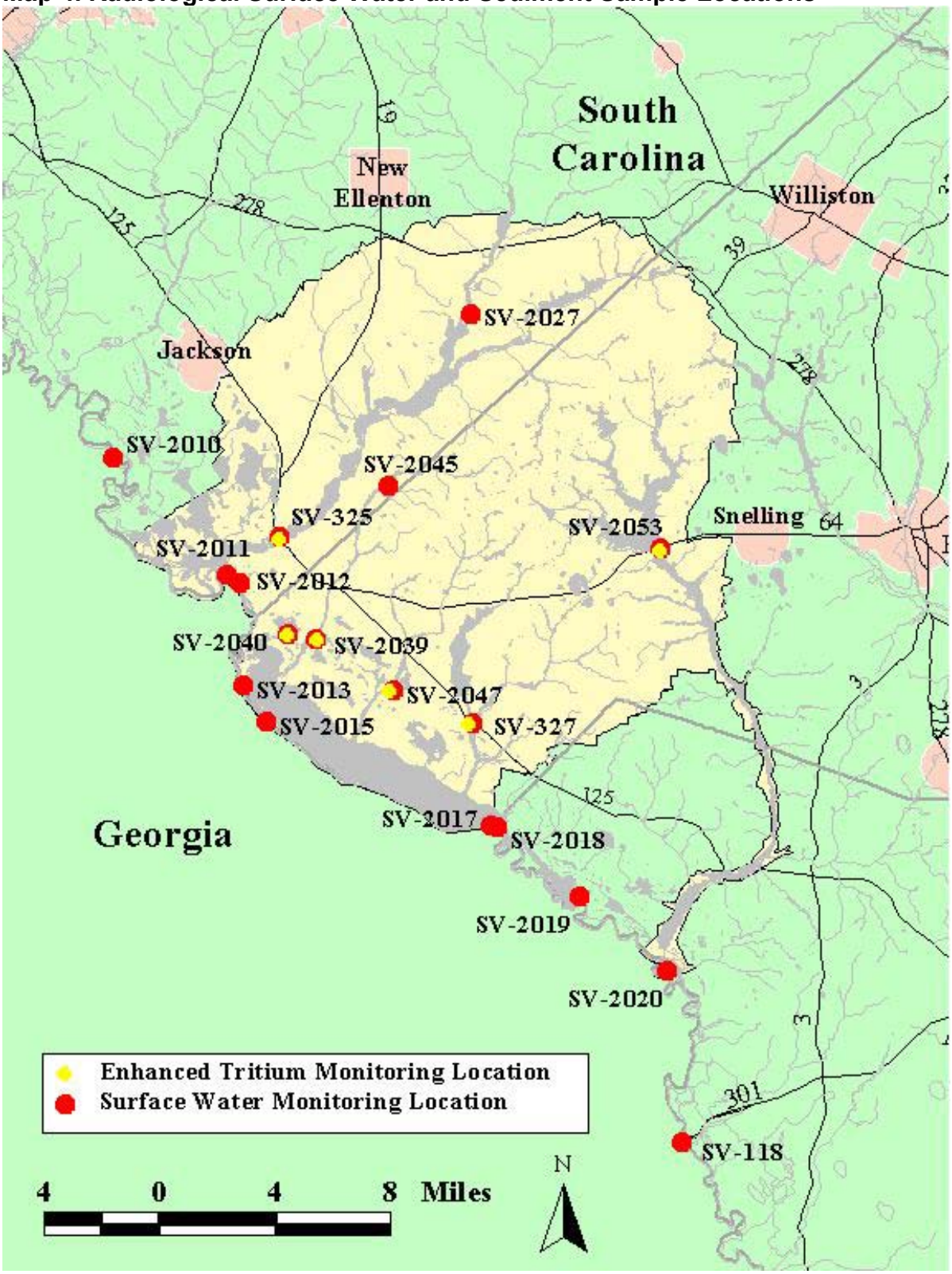


Figure 6. Mean Tritium Data Trends
Between ESOP and DOE-SR



Map 4. Radiological Surface Water and Sediment Sample Locations



Non-Radiological Surface Water and Sediment Monitoring

The streams located on the SRS receive treated wastewater and non-point source runoff from on-site facilities. Recent and historical data from SRS Environmental Reports indicate that the SRS waters are in accordance with Freshwaters Standard guidelines stated in the DHEC Water Classifications and Standards (Regulation 61-68), 1998.

ESOP assessed the non-radiological sediment and surface water quality on SRS by sampling the on-site streams for inorganic and organic contaminants. Specific parameters were analyzed monthly, quarterly, and annually. ESOP strategically chose sample sites (**Map 5**) to monitor ambient sediment and surface water conditions to detect any non-radiological impact from DOE-SR operations.

Sediment data from this study, as well as 2001 DOE-SR sediment data, indicate no measurable impacts from DOE-SR operations. However, a comparison of SRS and ESOP sediment data could not be completed because of different methods used for analyzing sediments. DHEC recommends that SRS consider utilizing methods that quantify constituents found in the sediment. Currently, SRS utilizes the Toxicity Characteristic Leaching Procedure (TCLP), which quantifies the constituents in the leachate. By using alternative methods, SRS and ESOP will be able to more accurately compare data.

The overall non-radiological water quality on the SRS meets the Freshwaters Standard for South Carolina streams. All but two of the surface water parameters, nitrate and pH, continue to be within expected ranges for South Carolina streams. Nitrate concentrations from the Four Mile Creek (SV-326) sample location were higher than comparable South Carolina streams (**Figure 7**). These elevated nitrate concentrations possibly result from waste treatment facility discharge into Four Mile Creek upstream from this location. Additional studies are being planned to discover the source of the elevated nitrate levels. Also, surface water pH from the Upper Three Runs (SV-2027) sample location was lower than comparable South Carolina streams (**Figure 8**). Further investigation is planned to determine if the source of the lower than expected pH. Data from ESOP non-radiological surface water locations were compared to DOE-SR data where sample points were colocated. The data from the colocated stations were similar for the parameters that were analyzed by both ESOP and DOE-SR.

ESOP will continue the non-radiological independent monitoring and surveillance of SRS surface water to verify and validate SRS surface water quality. The future locations, numbers of samples, sample frequencies and monitoring parameters may change to maximize available resources and address critical issues.

Figure 7. SRS and ESOP Nitrate Levels in Four Mile Creek

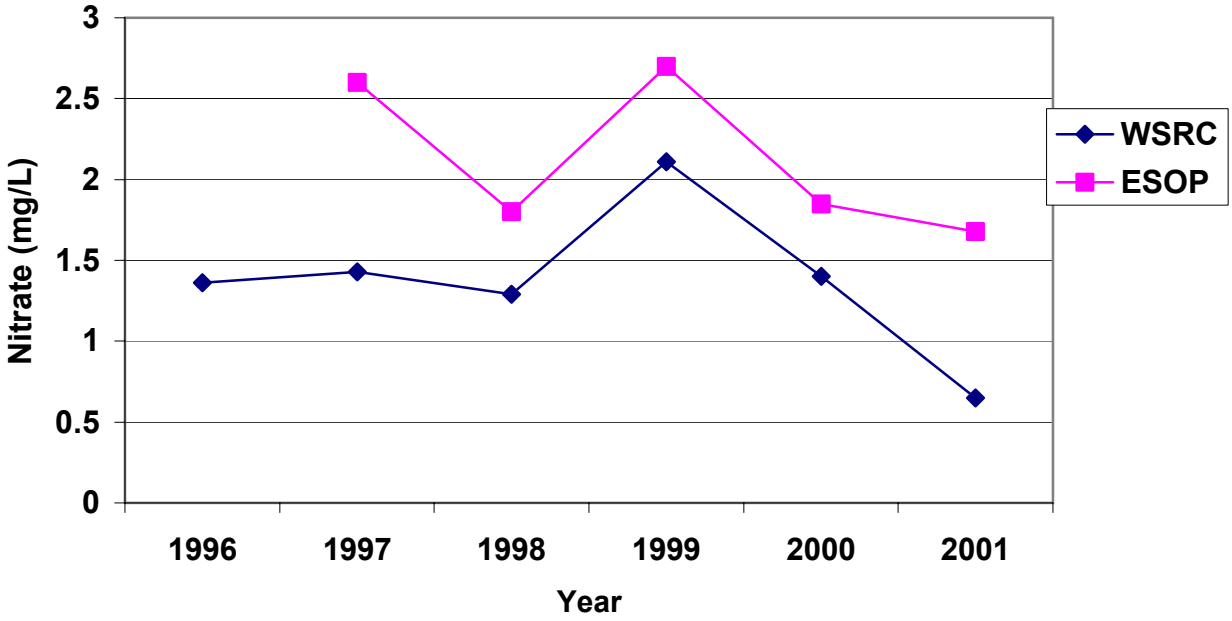
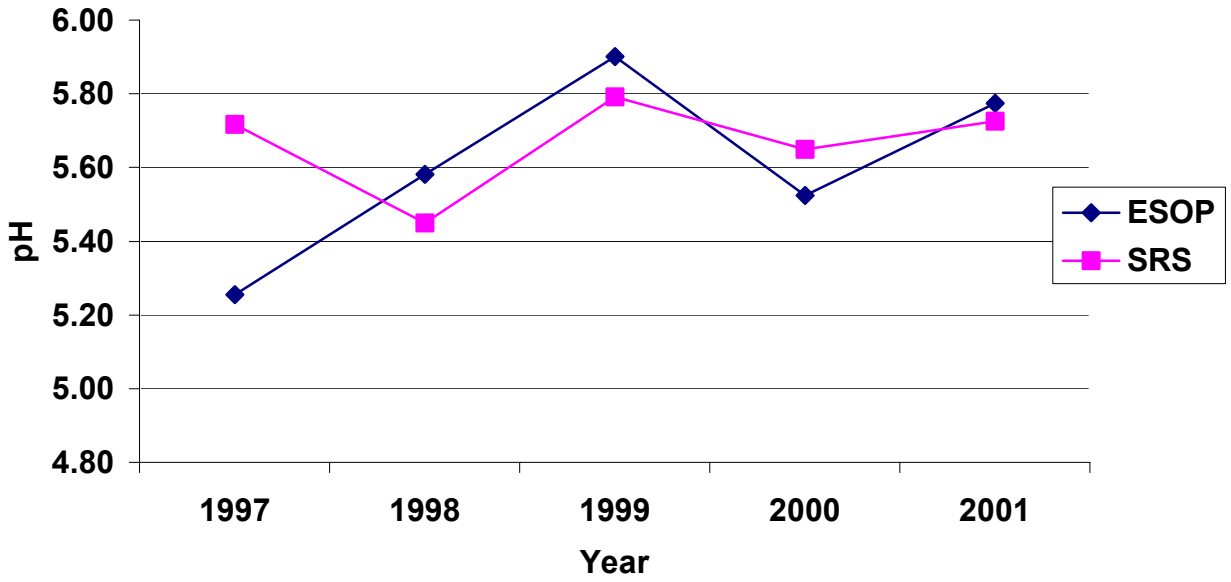
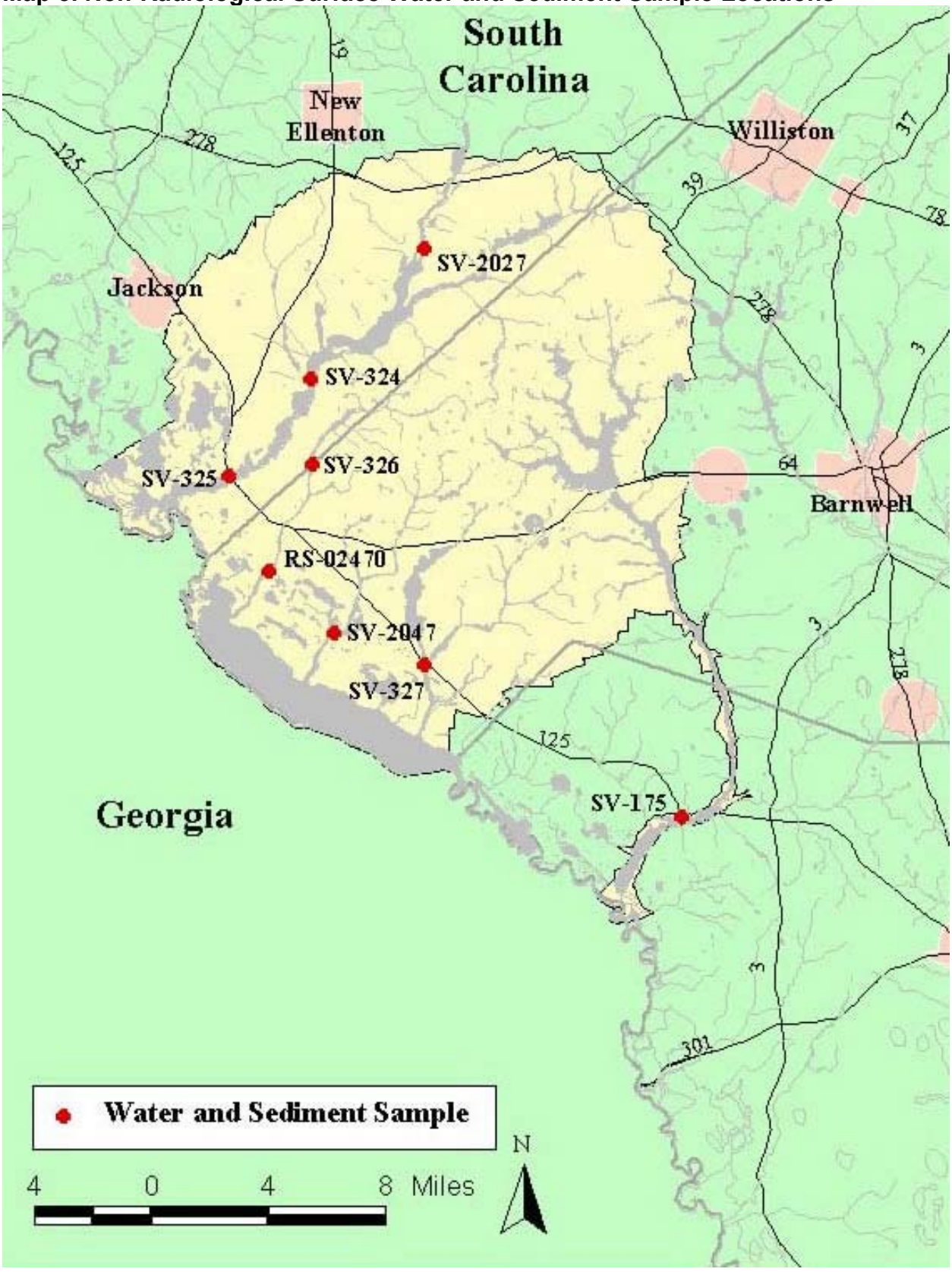


Figure 8. Average Yearly pH levels at Upper Three Runs



Map 5. Non-Radiological Surface Water and Sediment Sample Locations



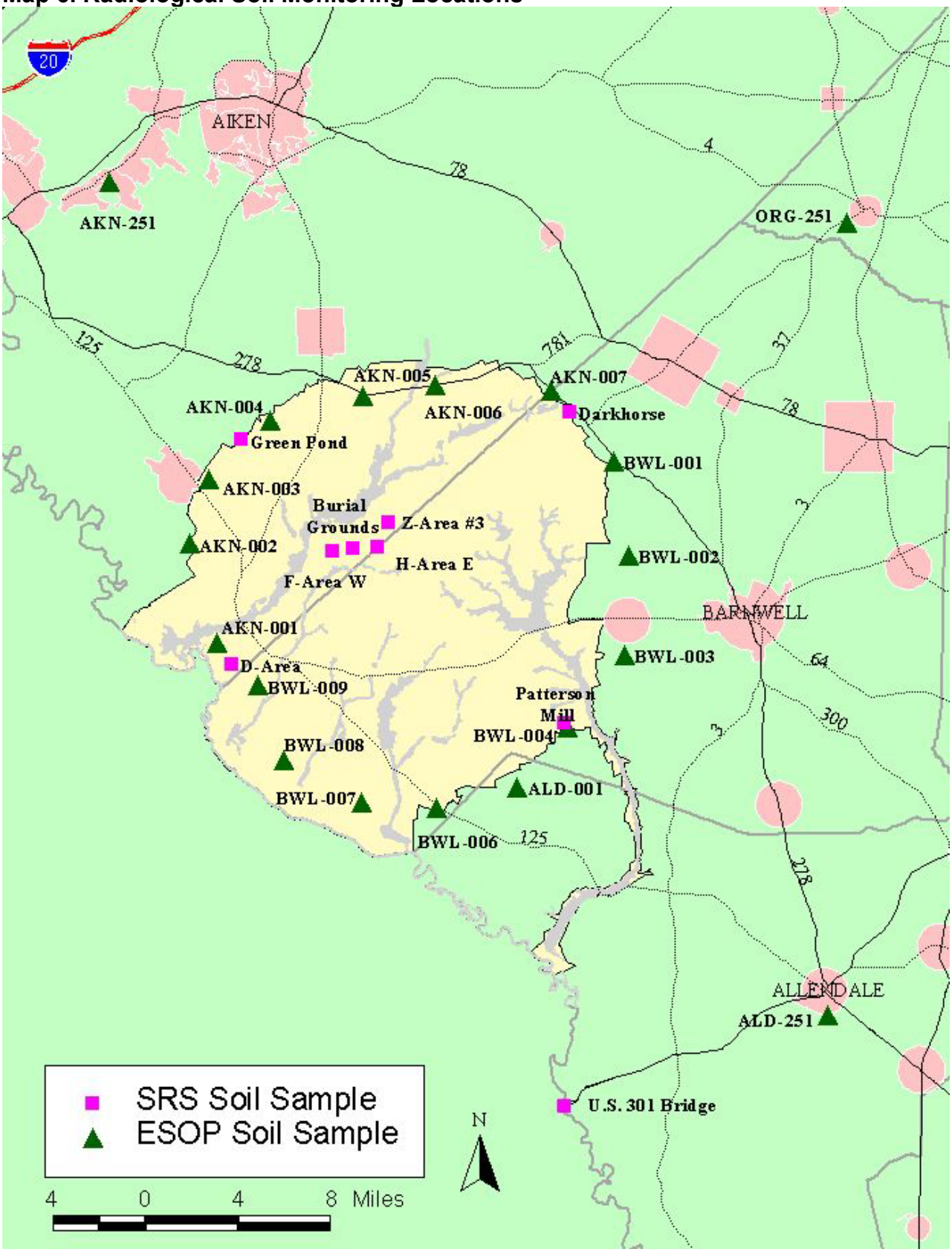
Radiological Surveillance of Surface Soils on and Adjacent to SRS

ESOP personnel evaluated surface soil radionuclide concentrations on and around the SRS in 2001. This project complements existing DOE-SR programs, helps verify DOE-SR data, and addresses public concern regarding decreased environmental monitoring at SRS. (DOE-SR soil monitoring has been reduced from 24 sample locations in 1994 to six sample locations in 1997). In 2001, ESOP expanded and reconfigured existing DHEC surface soil monitoring for thorough perimeter coverage of the SRS (**Map 6**). All samples were analyzed by a contract laboratory for Plutonium (Pu)-238, -239, -240. Analytical results were compared to DOE-SR environmental monitoring data. The data has been entered into a database maintained on the Lower Savannah District server. This data and reports are available to the public and other organizations upon request.

ESOP conducted soil monitoring at 20 locations in 2001: 16 locations around the perimeter of SRS, three locations 25 miles from the center of SRS (former DOE-SR environmental monitoring locations) and one location chosen at random from within a 50-mile radius of SRS (Map 6). Samples were collected from the surface to a depth of 4 feet during the spring of 2001.

In comparing DOE-SR data to ESOP data, the data reported by DOE-SR is on the order-of -one to two magnitudes less than that reported by ESOP. This could be a result of differences in the MDA's from each laboratory. The nature of the differences will be investigated further in 2002-3 to determine if they are significant.

Map 6. Radiological Soil Monitoring Locations



Radiological Monitoring of Terrestrial Vegetation On and Adjacent to SRS

ESOP monitors for the presence of radionuclides in vegetation around the SRS stemming from SRS operations. In 2001, ESOP conducted independent vegetation monitoring at 16 locations around the perimeter of the SRS; three former SRS monitoring locations 25 miles from the center of SRS; and four locations selected at random from within a 50-mile radius of SRS (**Map 7**). Sampling was performed in May and August 2001.

Samples from all stations were analyzed for tritium activity. Tritium was detected in vegetation at 18 of the 23 sites sampled in 2001. Eight of the perimeter stations produced tritium levels greater than the Lower Limit of Detection (LLD) in both sampling months. The stations with the highest detectable activity were generally located on the western and northern sides of the SRS, including vegetation collected near D-Area. This is possibly due to heavy water reprocessing and historical operations at that facility. Tritium was detected at two 25-mile stations but none of the randomly selected stations.

ESOP data confirms the DOE-SR conclusion that elevated tritium levels at the site perimeter are due to atmospheric releases from SRS. Despite monitoring and analysis differences, tritium results from the one location sampled by both programs were low or below detection limits (**Figure 9**). Both programs found the highest level of tritium in the vicinity of D-Area. Results for the colocation were similar for cesium-137**.** To facilitate comparisons, ESOP recommends that DOE-SR modify its reporting format for tritium, either to picocuries/milliliter, or as picocuries/gram of fresh vegetation (i.e. wet weight).

The ESOP vegetation monitoring program was changed in 2001 to concentrate on perimeter locations where Cs-137 was detected in vegetation in previous years. Samples from nine permanent stations and two randomly selected stations were analyzed for gamma-emitting radionuclides. At these locations, especially at stations on the northern and southeastern sides of the SRS, Cs-137 was detected at levels similar to 1998, 1999, and 2000 (**Figure 10**).

Figure 9. Tritium in Vegetation for DHEC and SRS
(No tritium detected in 1999 and 2000)

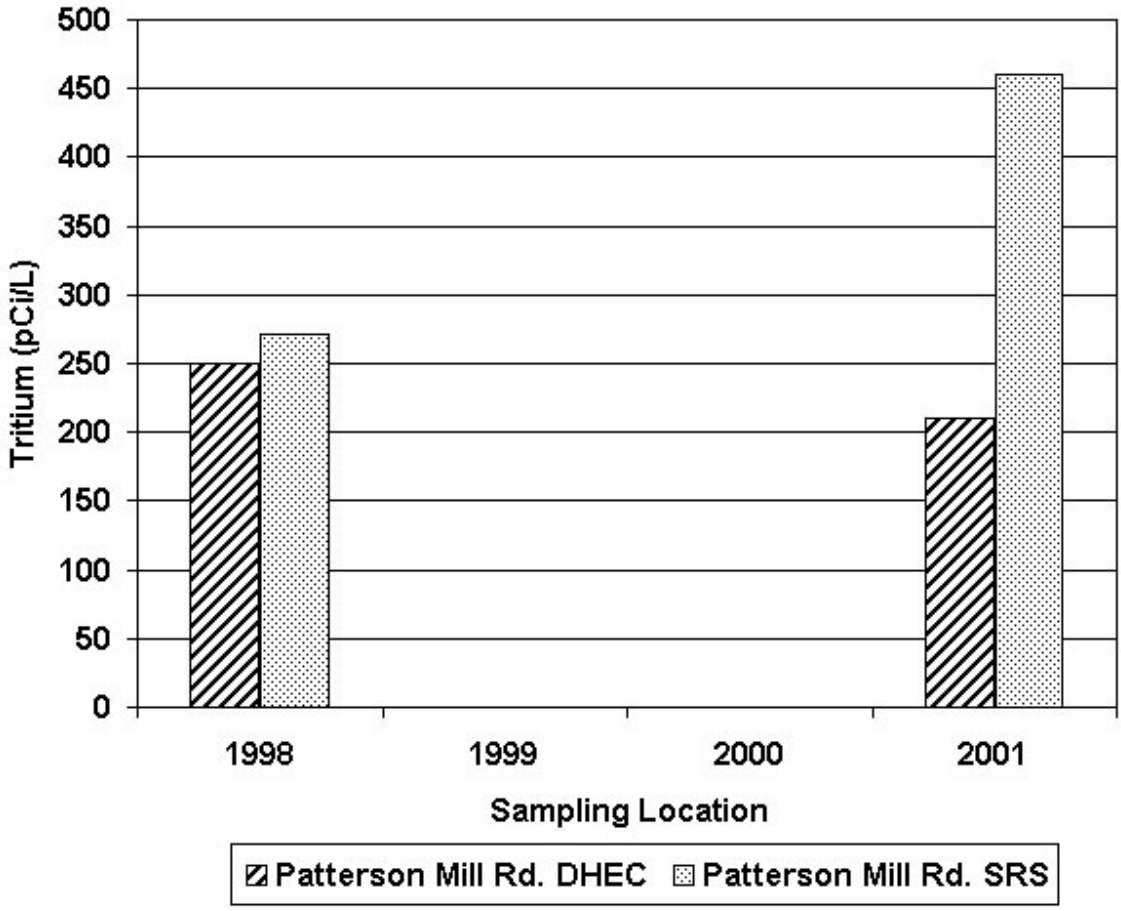
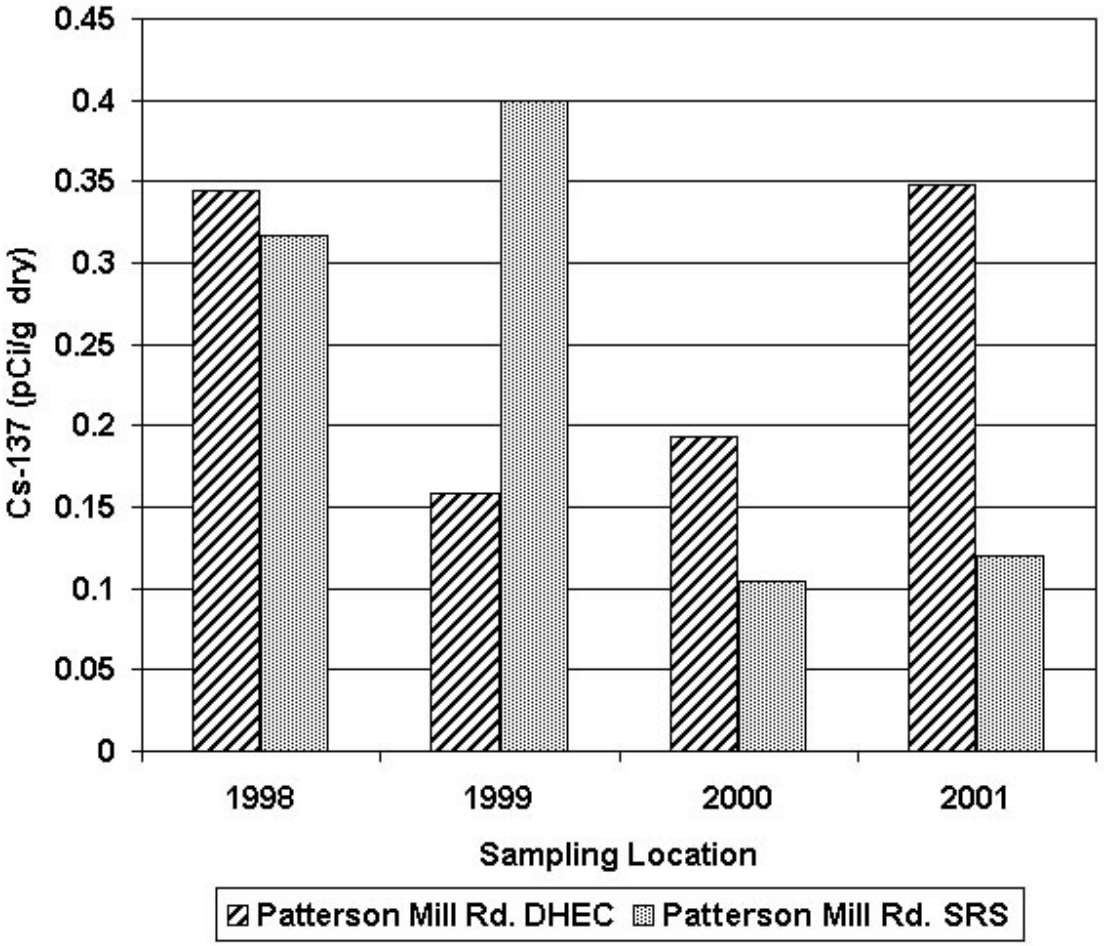
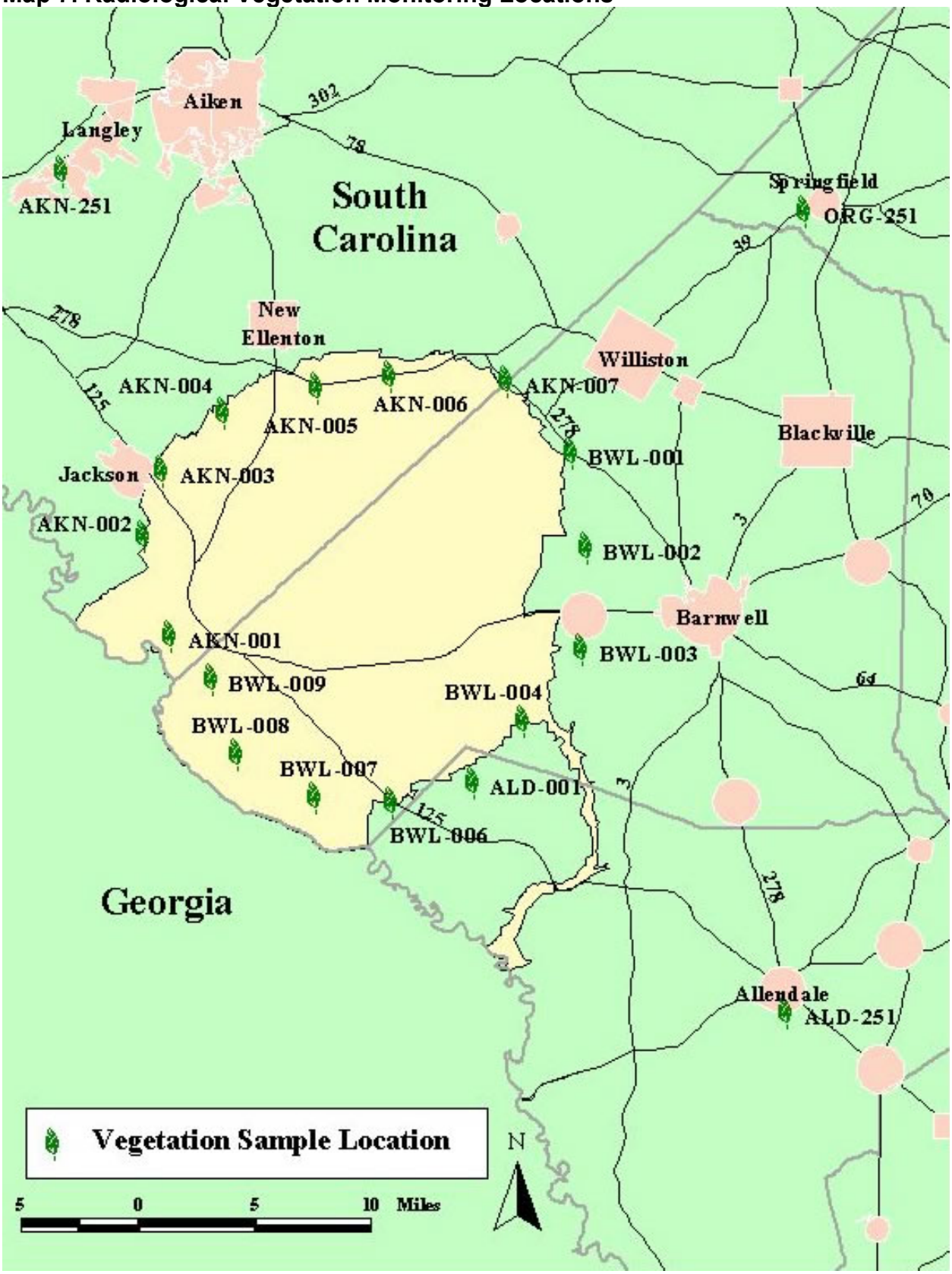


Figure 10. Cesium-137 in Vegetation for DHEC and SRS



Map 7. Radiological Vegetation Monitoring Locations



Radiological Monitoring of Dairy Milk

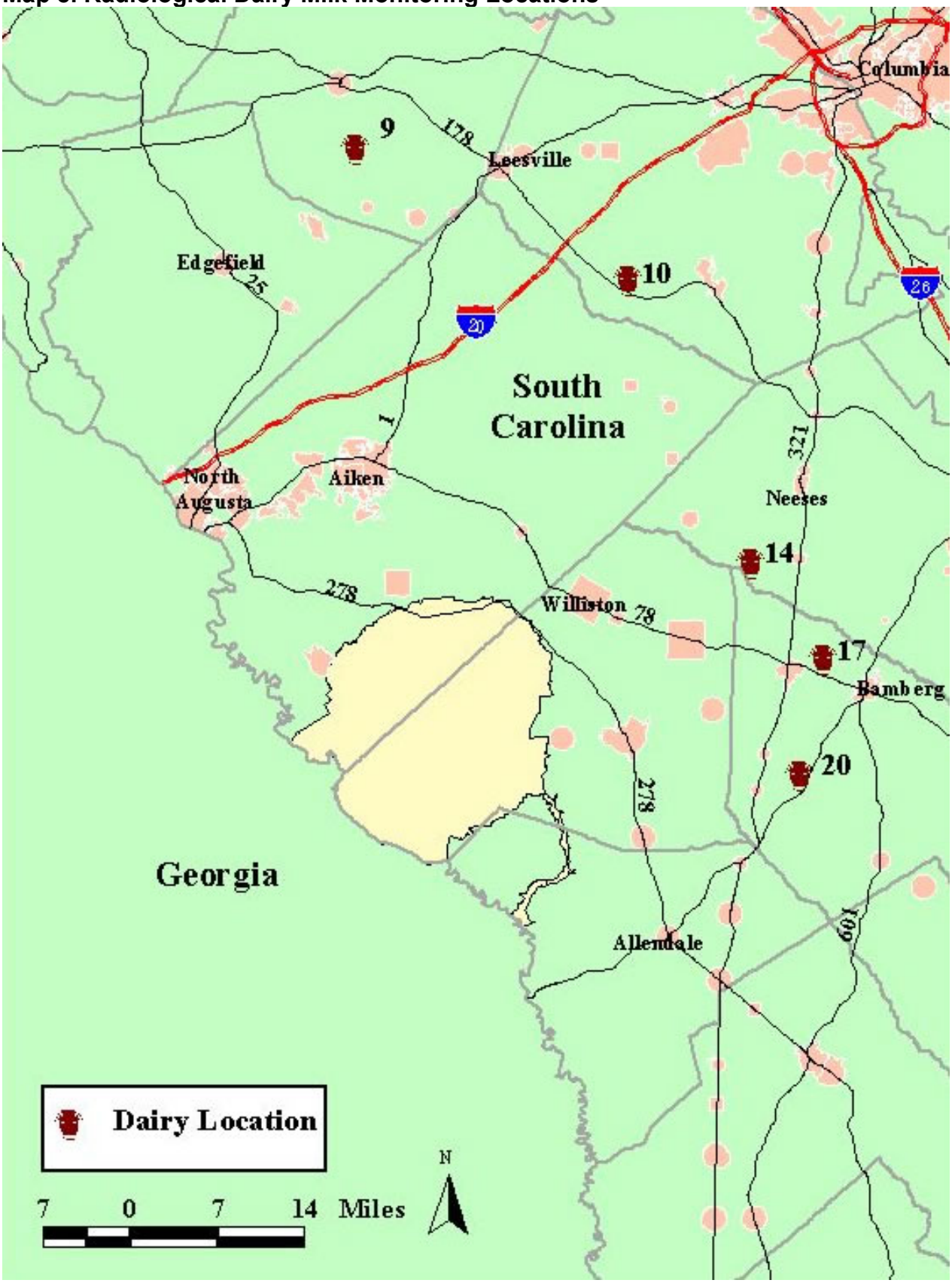
Consumption of milk and other food products containing radioactive materials is an important pathway for human exposure to radioactivity. Dairy milk can become contaminated through atmospheric deposition of radioactive particles on grass and plants that are ingested by cows, and transferred to milk. The milk pathway is of particular importance in the case of infants and children. Not only are they more likely to drink large quantities of milk, they are actively developing bones and teeth. Strontium, a calcium analogue, can bioconcentrate in bones and teeth displacing the calcium.

DOE-SR personnel have historically conducted monitoring around SRS to determine concentrations of certain radionuclides in dairy milk. Due to a change in the scope of production activities at SRS and closure of some local dairies, only five of the 17 sampling locations remain active. ESOP personnel performed dairy milk sampling at the five locations to provide an independent source of data on concentrations of radionuclides in milk within a 50-mile radius of the SRS (**Map 8**).

ESOP personnel collected the milk samples on a monthly basis in 2001. The samples were analyzed for tritium and select beta-gamma emitters. No tritium was detected above the LLD in any of the milk samples. Strontium-90 was only detected above the MDA in the background sample. No Cs-137 was detected in any of the 2001 milk samples.

An evaluation of the analytical results indicates consistency between the ESOP and DOE-SR programs for 2001. However, ESOP does not report values less than the MDA because the numbers cannot be accurately calculated. DOE-SR reports values below the MDA. Due to the difference in reporting methods, the results are limited in scope.

Map 8. Radiological Dairy Milk Monitoring Locations



Radiological Fish Monitoring Associated with the Savannah River Site

ESOP conducts monitoring of radionuclide activity in fish in an effort to determine the magnitude and extent of radionuclide levels and to determine if any trends exist. Five bass and five catfish were collected from each of 10 sample locations.

Fish were collected using boat mounted electrofishing equipment. Samples were collected at five stations where creeks from the SRS meet the Savannah River (**Map 9**). In addition, samples were collected at one Savannah River station upstream of the SRS, two stations downstream of the SRS, and two background locations. All fish were composited by species and sample location, and separated into edible and non-edible homogeneous portions. Composites were analyzed for gamma-emitting isotopes and tritium. The non-edible portions of bass and catfish composites from Savannah River stations were also analyzed for strontium.

A review of ESOP data indicates that DOE-SR operations have impacted fish. Higher levels of radionuclides are found in Savannah River fish collected adjacent to SRS compared to upstream and downstream. Fish from background locations tend not to exhibit detectable levels of man-made radionuclides (**Figures 11 – 16**).

For 2001, the project attempted to determine if activity levels in larger fish might impact a composite of relatively smaller fish. Individual portions of two bass and one catfish, considerably larger than the other fish sampled, were analyzed separately and compared to their respective composites. Results of tritium analyses showed no significant difference between the samples. Cs-137 levels from the individual bass samples were also very similar to the composites. The individual catfish samples, however, produced an activity level an order-of-magnitude greater than the composite sample. This was similar to comparison results in 2000. Collections of larger fish continued in 2002 in order to provide additional data for assessment of this trend. Based on a review of that data, large catfish may be eliminated from composite samples.

DOE-SR also conducts fish monitoring to assess the environmental effects of current and historical releases of radionuclides. ESOP data were compared to DOE-SR reported results. Compared tritium and Cs-137 data were not similar for several locations, including Upper Three Runs, Steel Creek, and Lower Three Runs. Discrepancies in these results could be attributed to the natural variation of radionuclide levels. Although there are differences between reported values, the data is consistent with historically reported data. In the past, samples have been collected and split between ESOP and DOE-SR for analyses, and no discrepancies in the data results were found.

Independent monitoring of radionuclide levels in Savannah River fish will continue along with evaluating the DOE-SR Radiological Fish Monitoring Program. Five American shad were collected from one location as part of an ongoing effort to sample additional species in each study year. This will augment the existing data on Savannah River fish, and provide information for human health assessment. Project information will be available for the DHEC Bureau of Water and the Health Hazard Evaluation Division to further evaluate potential human health risk associated with the consumption of Savannah River fish. The information provided will also help in advising, informing, and protecting the people at risk, and in comparing current and historical data.

Figure 11. Tritium in Edible Bass for DHEC and SRS

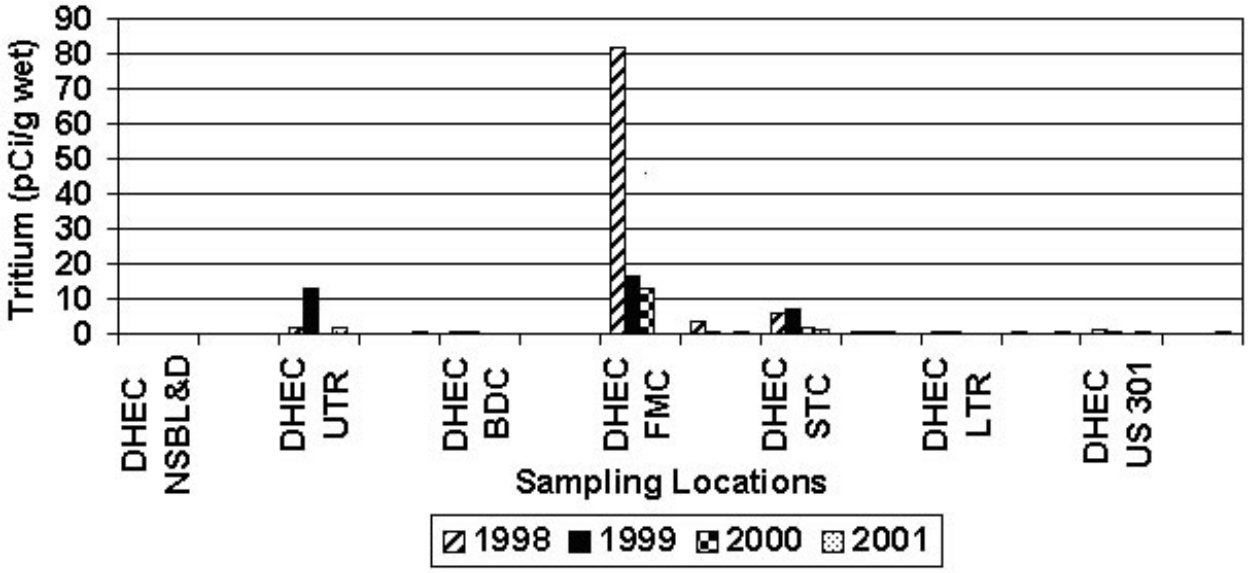


Figure 12. Tritium in Edible Catfish for DHEC and SRS

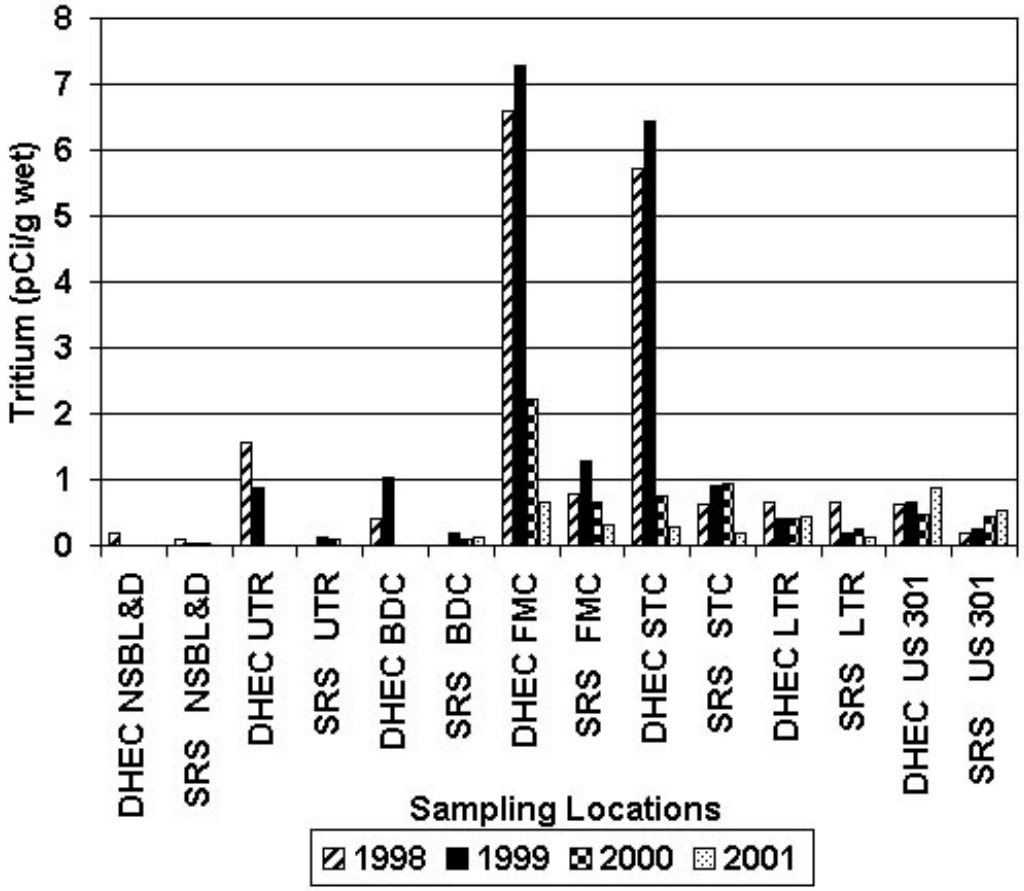


Figure 13. Cesium-137 in Edible Bass for DHEC and SRS

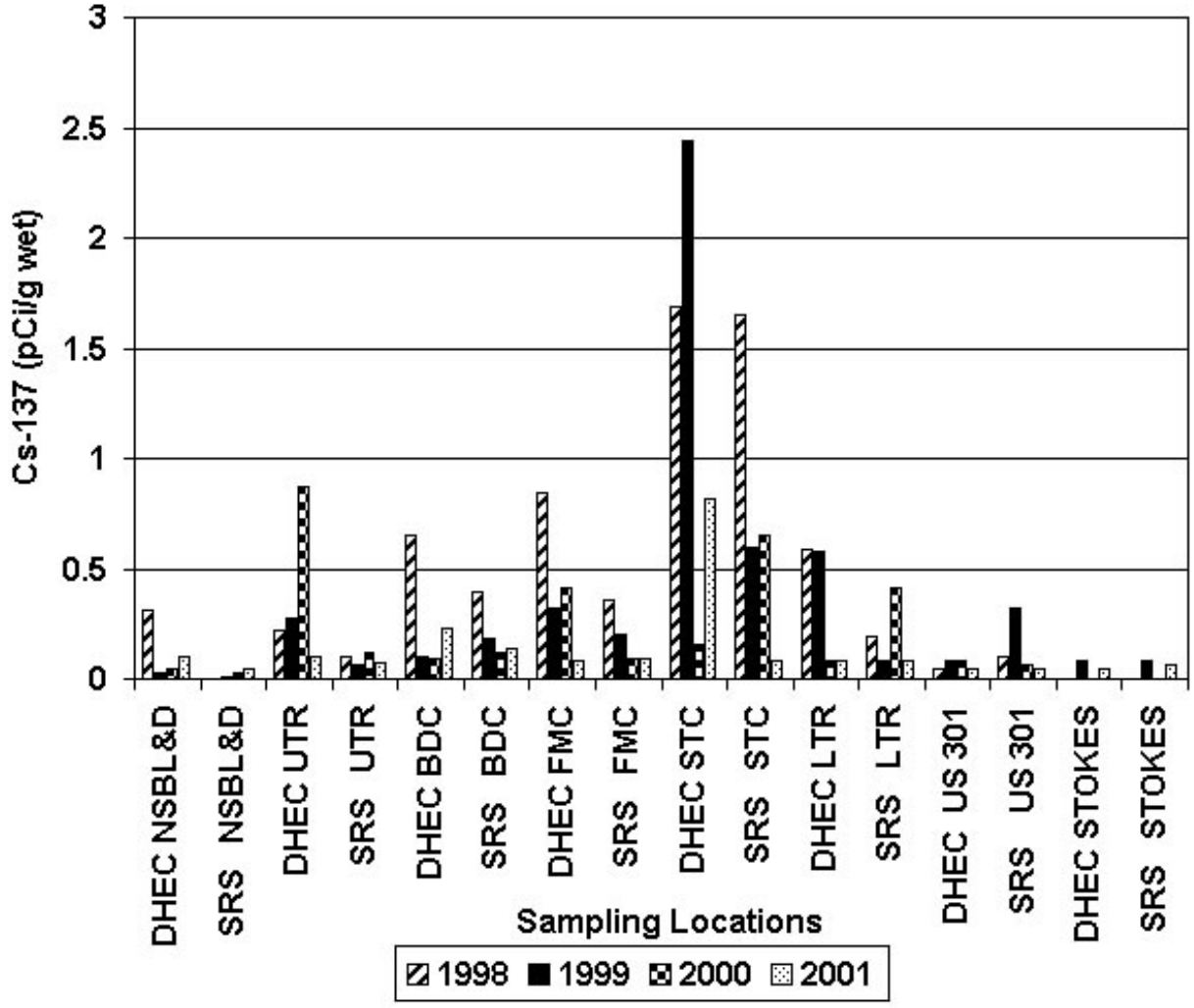


Figure 14. Cesium-137 in Non-Edible Bass for DHEC and SRS

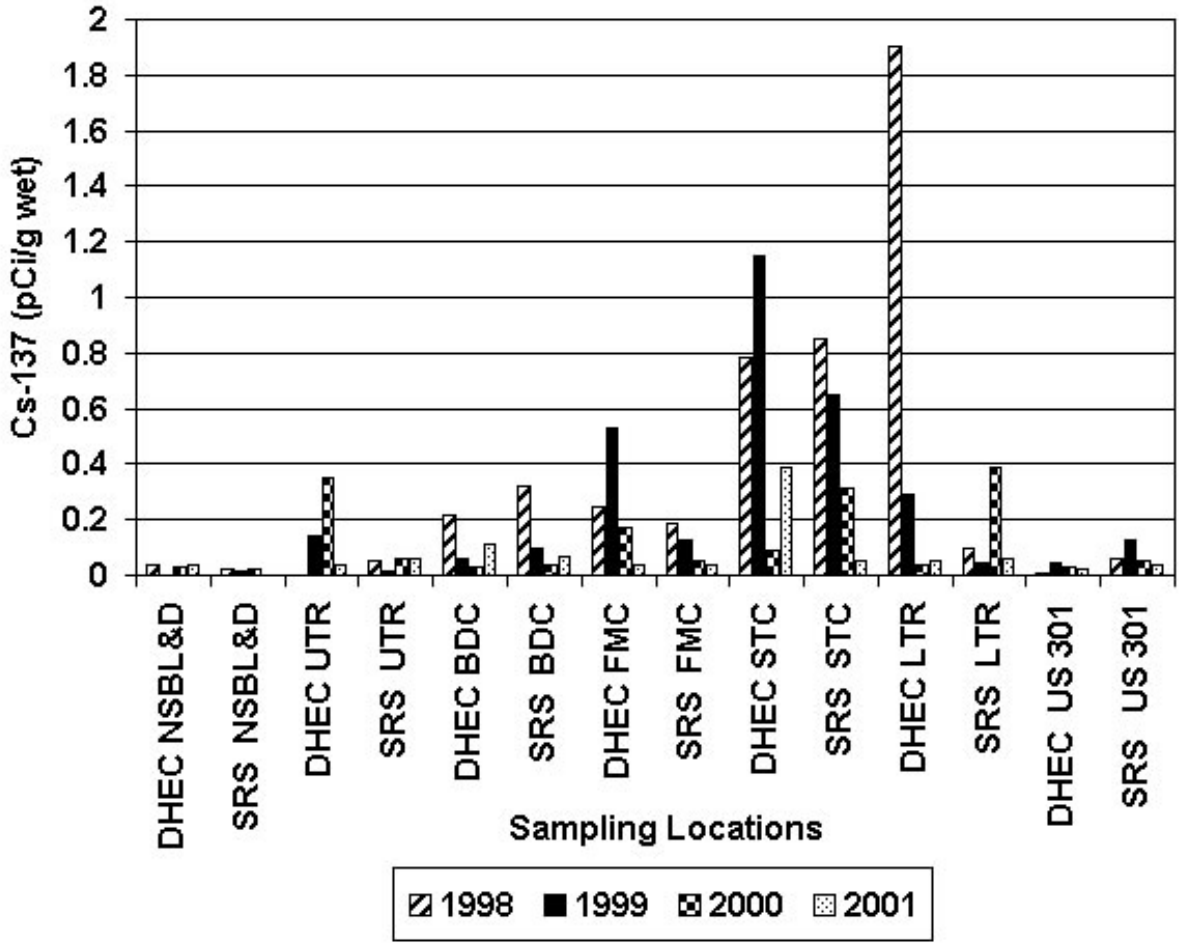


Figure 15. Cesium-137 in Edible Catfish for DHEC and SRS

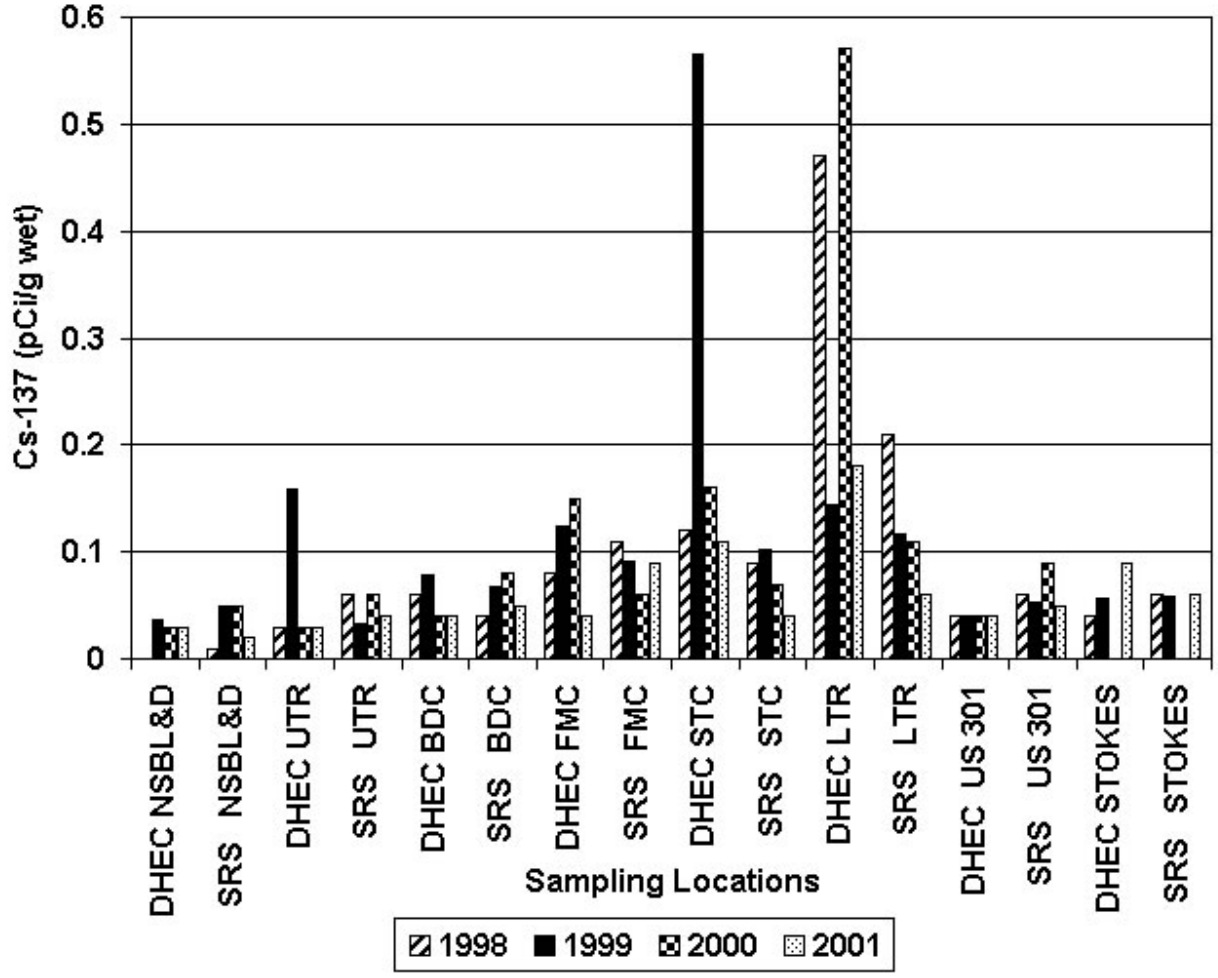
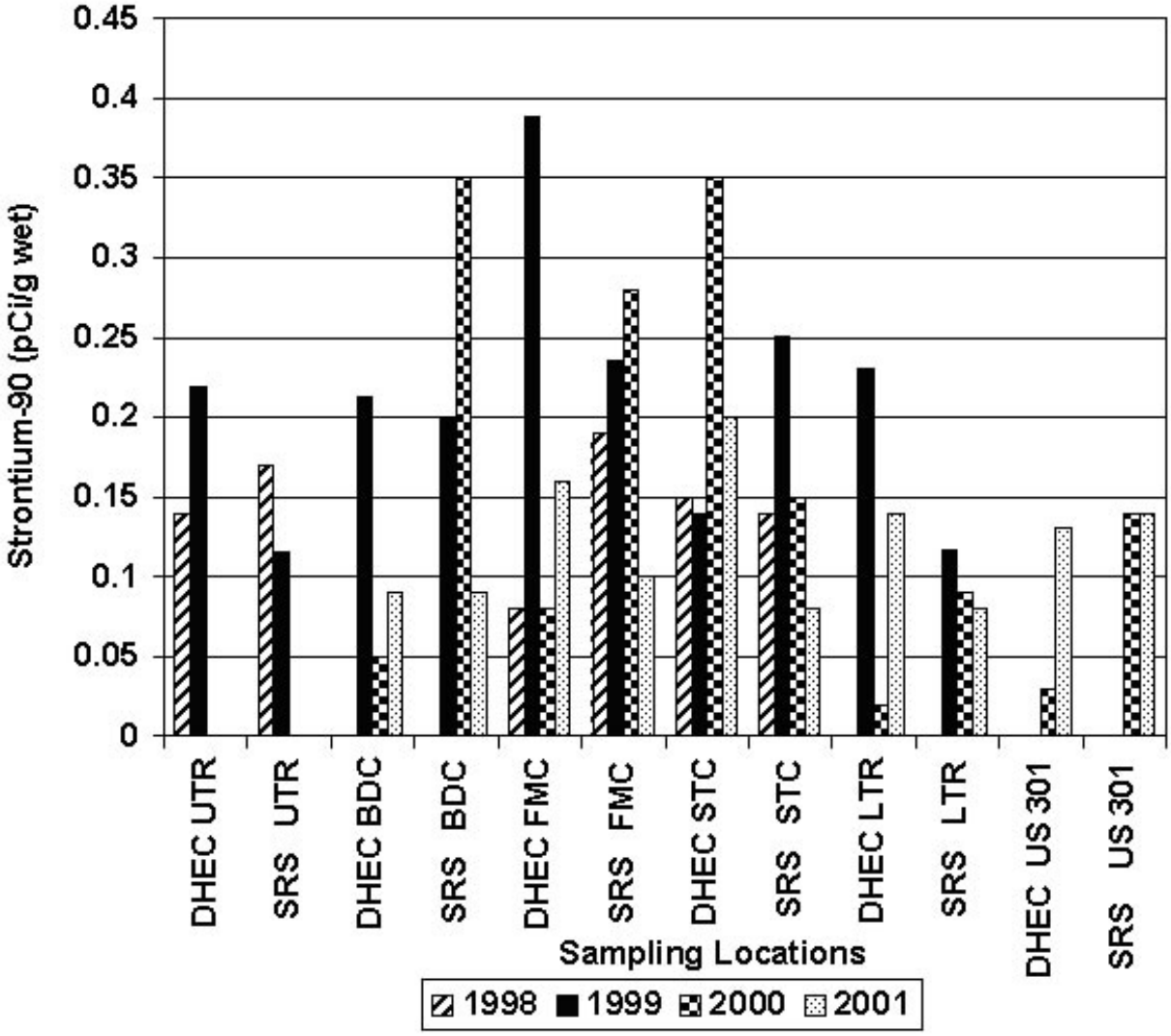
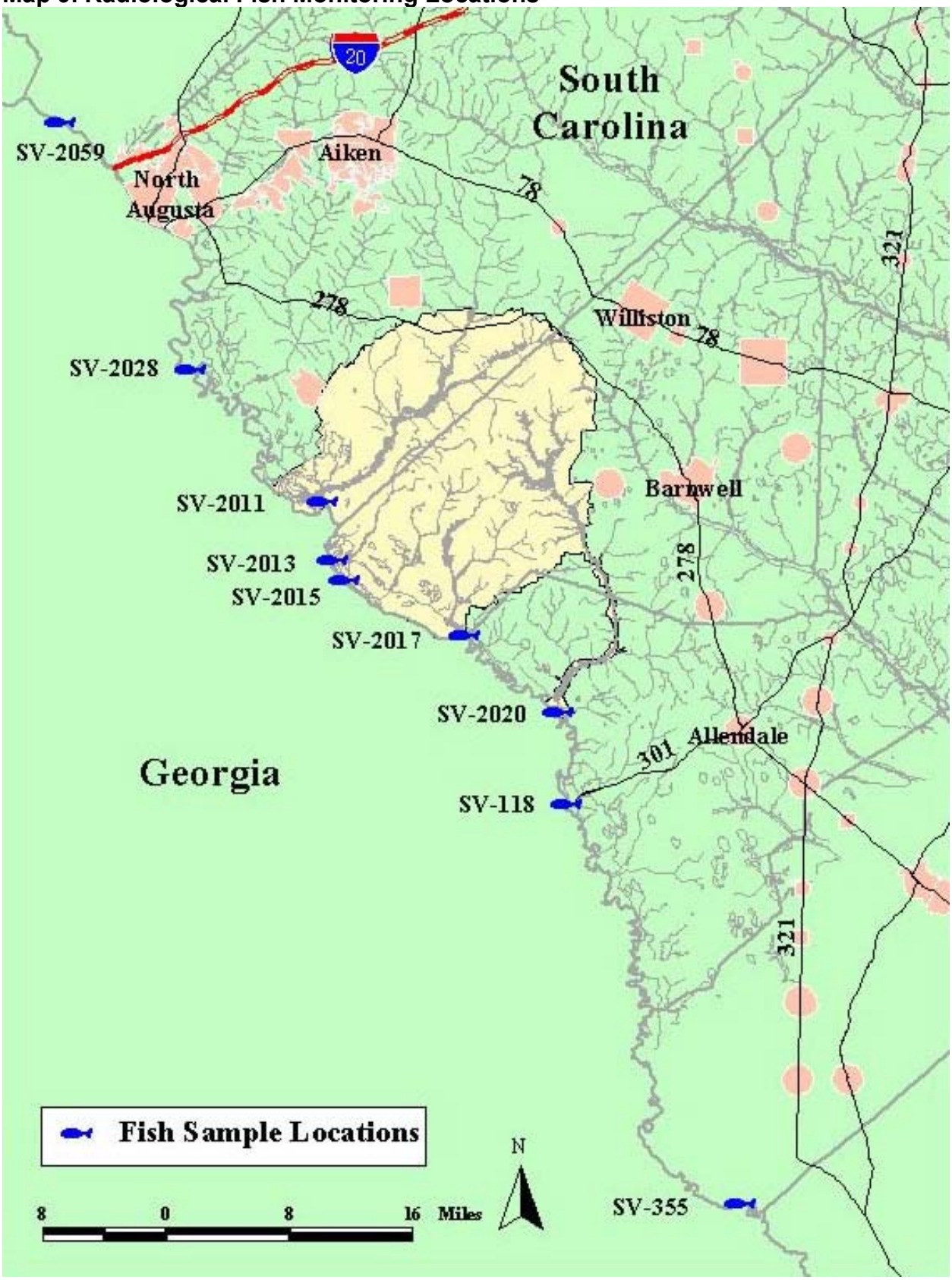


Figure 16. Strontium-90 in Non-Edible Catfish
for DHEC and SRS
(Blanks denote no comparable analyses)



Map 9. Radiological Fish Monitoring Locations



Radiological Game Animal Monitoring Adjacent to SRS

White-tailed deer and feral hogs have access to a number of contaminated areas on the SRS, and consequently are a vector for the redistribution of contaminants to off-site locations. ESOP conducts the game animal study to address concerns of potentially contaminated white-tailed deer and feral hogs migrating off the SRS by analyzing game samples collected off-site. The precise ranging behavior of individual deer and hogs on the SRS is unknown. Deer and hogs have access to contaminated areas on-site and some animals may migrate off-site where local hunters can harvest them. The radionuclide of concern is Cs-137 because of its relatively long physical half-life of 30 years, and it's availability to game animals and associated health risk to humans. Sampling by ESOP of deer and hogs harvested off-site can provide valuable information concerning the potential off-site exposure to Cs-137. ESOP off-site dose estimates are higher than DOE-SR modeled values for the local hunting population. Consumption of these wildlife species can result in the transfer of contaminants to humans. This would explain why the 30-year projected risk (3.6E-04) for the off-site hunter exceeds all other standard pathways combined.

In 2001, DHEC analyzed muscle tissue for Cs-137 from 35 deer and one hog from within a five-mile study area adjacent to the SRS (**Map 10**). Five tissue samples were also collected and analyzed from a background location 50 miles northeast of the SRS. Study area and background data were similar, with a slightly higher mean Cs-137 concentration in deer samples from the study area. Cs-137 data ranged from 0.06 to 4.06 picocuries per gram (pCi/g) for deer within the five-mile study area adjacent to the SRS. Cs-137 data ranged from 0.78 to 1.34 pCi/g for deer at the fifty-mile background location.

Game Dose Estimates

The DOE-SR estimated the potential average dose to a hypothetical off-site hunter in 2001 to be 0.53 millirem (mrem). The DOE-SR dose estimates for the past five years are indicated in **Figure 16** . A Cs-137 concentration of 1 pCi/g is subtracted from the on-site average concentration before calculating the dose. The 1 pCi/g is based on an average background concentration of Cs-137 calculated from previous studies performed at the SRS.

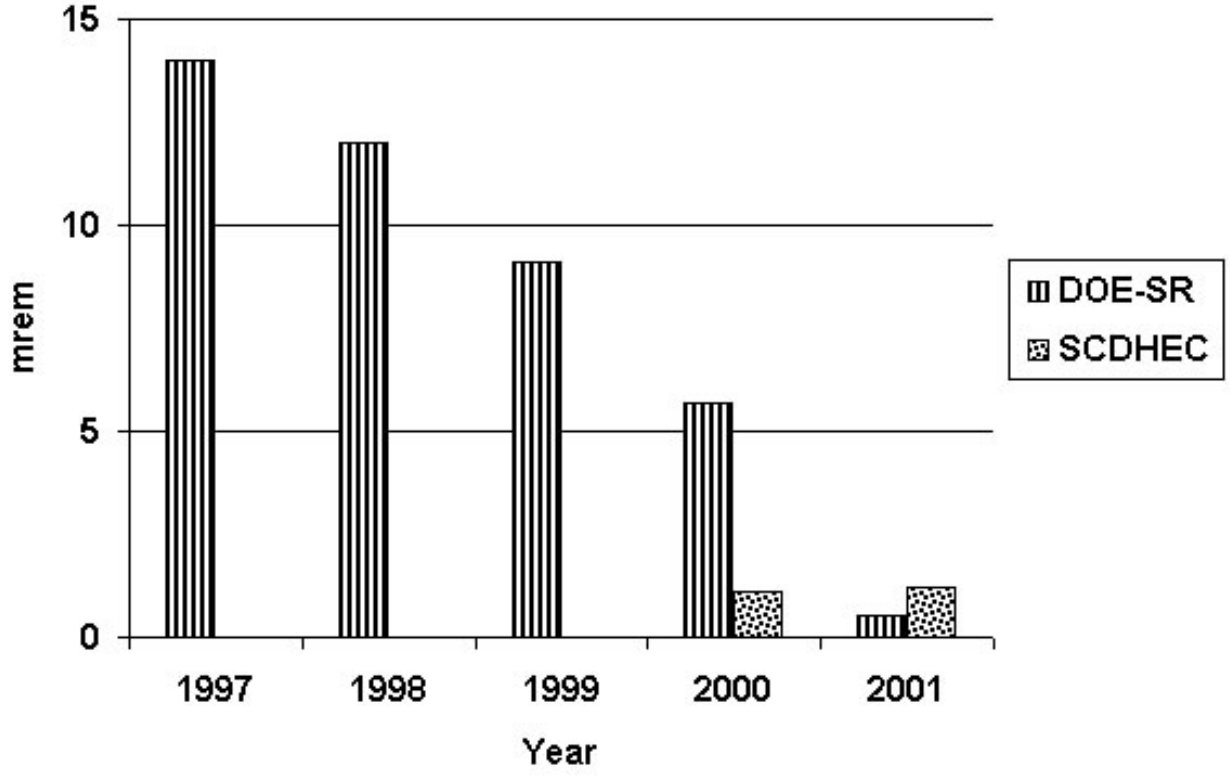
According to 2001 data results, ESOP estimated the maximum dose that could have been received by an offsite hunter at 9.5 mrem. The dose was also estimated to be 4.7 mrem after the average Cs-137 background concentration of 1.14 pCi/g was subtracted from each animal harvested. These dose estimates were for a single hunter who harvested five animals during the 2001 season. The hunter dose calculation is based on the conservative assumption that the hunter individually consumed the entire edible portion of the five deer he harvested, approximately 198.2 pounds.

Dose from study area animals was calculated by using International Commission on Radiation Protection (ICRP)-30 dose conversion factor for the ingestion of Cs-137 (5.0E-05 mrem/pCi), the edible fraction of each animal (0.45), and the conversion factor for grams to pounds (454 grams/lbs). Also used in the calculation was the live weight in pounds (lbs) and the Cs-137 concentration (pCi/g) of the sample.

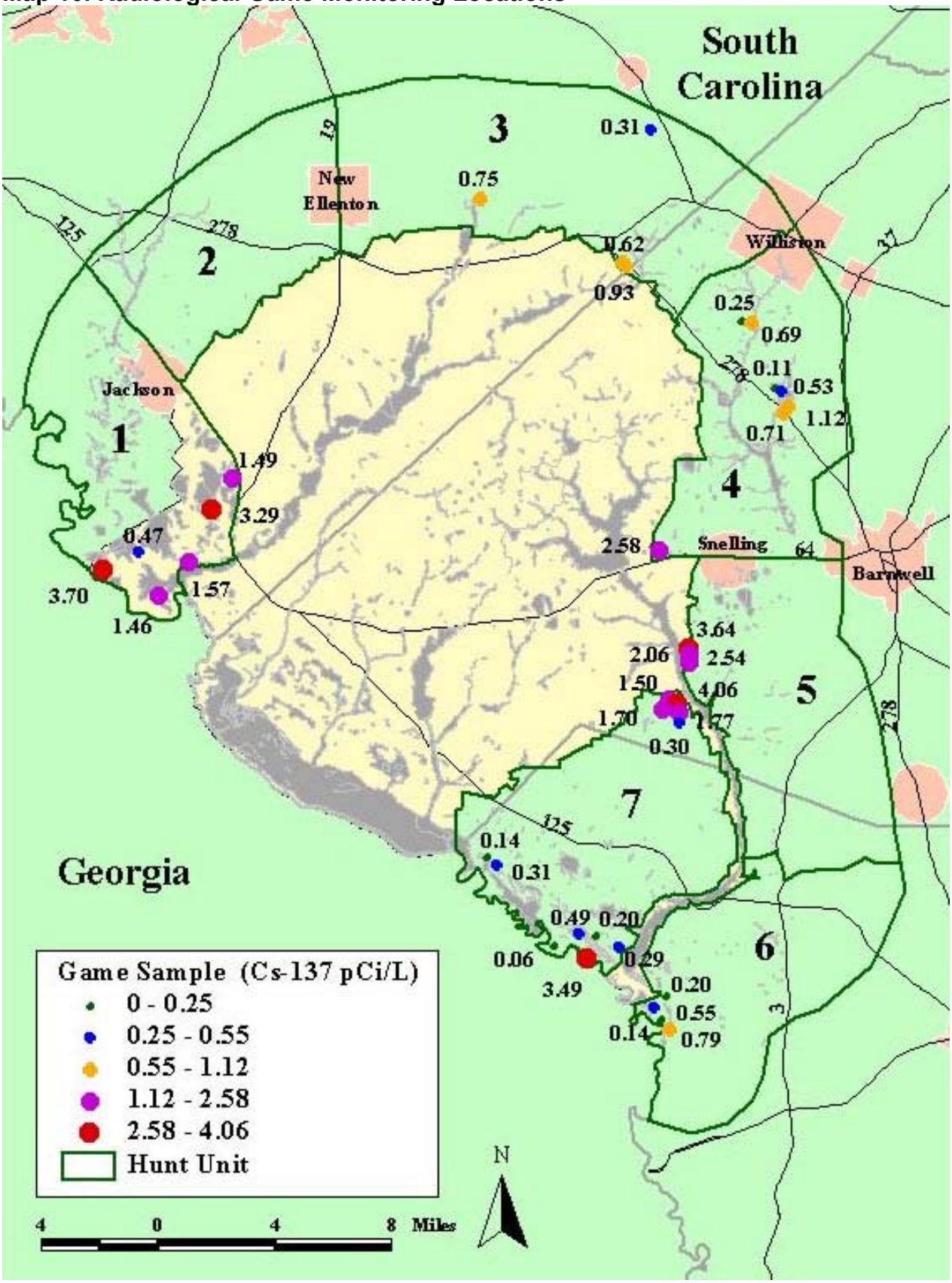
The hunter dose results were calculated by using the formula:

(mrem) = [5.0E-05 x 0.45 x 454] x live weight (lbs) x Cs-137 concentration.

Figure 17. Game Animal Average Off-site Dose



Map 10. Radiological Game Monitoring Locations



Benthic Macroinvertebrate Monitoring at the Savannah River Site

DOE has historically conducted monitoring on and around the SRS to determine the effects of facility operations on the environment. In this study, ESOP personnel conducted macro-invertebrate sampling at 20 locations (**Map 11**) on SRS in the fall of 1999. In addition, water samples from all sites were analyzed for tritium and sediment samples from 17 stations were analyzed for gamma-emitting isotopes. Various indices were used to analyze the macroinvertebrate population at the sampling stations, including taxa richness, Biotic Index, and Bioclassification Score. Results were compared between stations to see if there were any changes in the aquatic macroinvertebrate communities associated with radionuclides in SRS streams**.**

Tritium activity was detected in all surface water samples with the exception of the sample from Tinker Creek, located in the upper reaches of the Upper Three Runs watershed near the SRS boundary. Tritium levels were very high in the lower reaches of the Fourmile Branch watershed, in Indian Grave Branch, and in Pen Branch below the Indian Grave confluence.

Cs-137, a man-made radioisotope, was detected in 11 sediment samples, with the highest activity level occurring in a sample from Four Mile Creek. A high level of thorium-234 was detected in a sample from the upper station on Tims Branch, below A- and M-Areas. The only other sediment sample with a detectable level of thorium-234 was from the lowermost Pen Branch station.

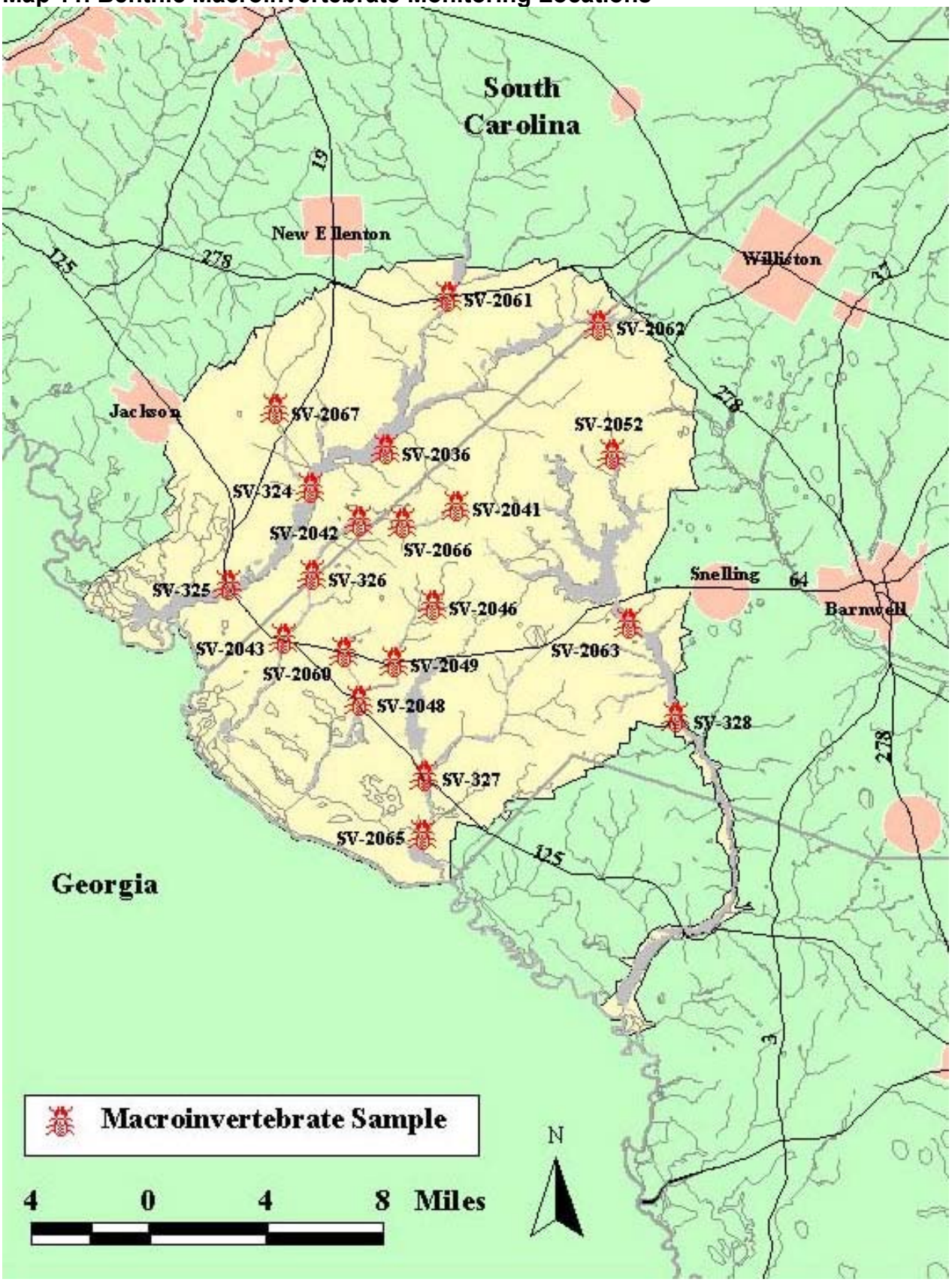
With the exception of the upper station on Tims Branch, all locations sampled in the Upper Three Runs watershed appeared healthy and unimpacted by SRS operations. The upper Tims Branch station however, did not support a macroinvertebrate community as healthy as similar sites located near the headwaters of other SRS streams.

Fourmile Branch and Pen Branch had stations located in the lower reaches of their watersheds that appeared to be negatively impacted compared to the upstream reference stations. Although non-radiological factors (National Pollutant Discharge Elimination System discharges, post-thermal habitat) could have influenced the results, a major difference between the lower stations and the upstream stations was the high levels of tritium at the lower stations.

The two stations sampled on Steel Creek were relatively healthy, especially considering the short distance between the upper station and the L-Lake cooling reservoir dam located upstream.

Three stations were sampled on Lower Three Runs. The upper station above Par Pond exhibited a healthy diverse community, even though the stream is quite small at that location. The middle station appeared to be impacted by deposited sediment that had washed downstream as the result of work done in the stream below the Par Pond dam. The lowermost station exhibited a very healthy macroinvertebrate population, indicating a good recovery from the impact that had occurred upstream.

Map 11. Benthic Macroinvertebrate Monitoring Locations



Oversight Monitoring and Support Activities

The ESOP Oversight Monitoring Support Projects are tasked with conducting document reviews; establishing contacts concerning sampling activities at potential SRS clean-up sites; providing independent oversight of the sampling activities; conducting split soil sampling; and acquiring, validate, and reporting discrepancies in data. ESOP personnel evaluated two sites in 2001. Both sites included the acquisition of split soil samples and the oversight of field activities from selected sample locations. These split samples were shipped to the DHEC Analytical Services Division (ASD) Laboratory for analysis of metals and semi-volatiles as per EPA SW-846 methodology.

Summaries of Federal Facility Agreement (FFA) sites

L-Area Early Construction or Demolition (ECOD), ECOD L-2

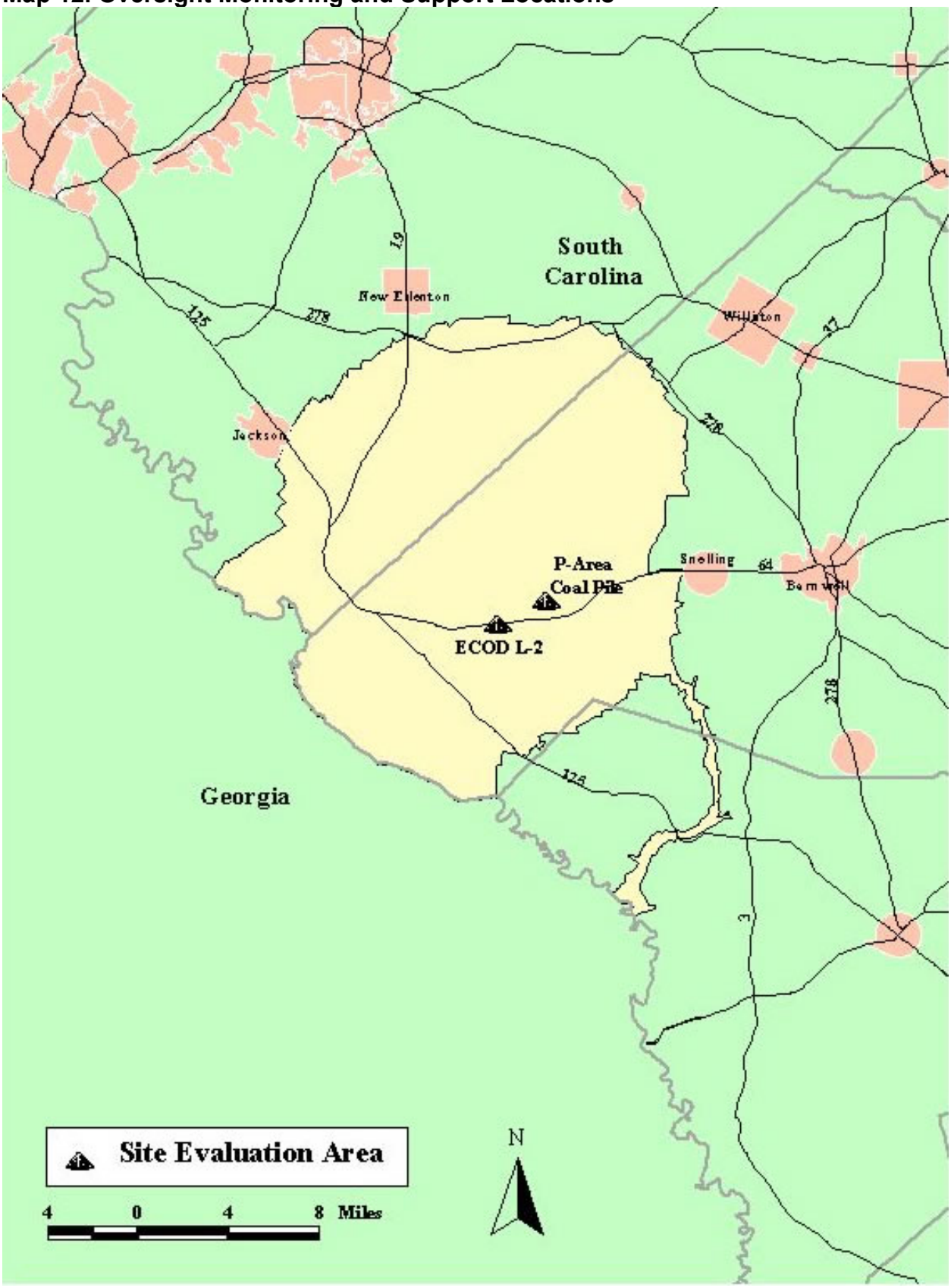
ECOD L-2 is located in L-Area of the DOE-SR (**Map 12**). This area is composed of two trenches that are approximately 60 by 150 feet. The L-Area ECOD was used from 1953 to 1954. The site was planted in trees during 1958. Typically, ECOD trenches contained miscellaneous construction debris (concrete, wire, scrap metal, etc.). DOE-SR personnel collected soil samples. ESOP personnel split soil samples from three locations. The samples were analyzed for Target Analyte List (TAL) constituents by the DHEC ASD laboratory. DHEC analytical data was comparable with DOE-SR with no significant anomalies noted.

P-Area Coal Pile

The P-Area Coal Pile is an area of concern listed in Appendix G.1 of the FFA. This area is located in P-Area of the DOE-SR. The P-Area Coal Pile was used as an unsheltered storage for stoking coal for the coal fired power plant in P-Area. The power plant operated from 1953 to 1990 and was dismantled in 1997. The remnants of the coal pile were removed in 1998 and the coal storage area was excavated to a depth of two feet with a layer of topsoil replacing the excavated soil. The primary objective of the sampling activities was to evaluate the potential impact on surrounding soil due to operations at this site. Soil samples were collected by DOE-SR personnel and analyzed for TAL and Target Compound List constituents. ESOP personnel split soil samples from four locations. The DHEC ASD laboratory analyzed the samples. DOE-SR data indicated the presence of Arsenic above the established Preliminary Remediation Goal (PRG). Additional Arsenic sampling is being planned on and around the SRS to further investigate the nature and extent of Arsenic levels on SRS.

ESOP will continue to provide field support and oversight through prescreening, split sampling, and independent sampling of site evaluation and remediation sites at DOE-SR. Data verification and validation and GIS databases will be incorporated into the project activities. The project findings will assure confidence in data supplied by DOE-SR. To facilitate comparisons, ESOP recommends that analytical detection limits reflect the established PRGs.

Map 12. Oversight Monitoring and Support Locations



New Initiative: The Critical Pathway Assessment Project

ESOP has initiated a critical pathway assessment to identify the radiological contaminants and pathways associated with the SRS. This assessment will identify the primary contaminants and pathways that are important from a public health point of view. This information will also be the basis for evaluating the existing DOE-SR Environmental Monitoring Section's environmental monitoring program around SRS in later reports.

Project activities have primarily consisted of researching various publications on past SRS releases and pre-operational plans on new SRS facilities to develop an independent critical pathway assessment of the SRS. This initial research is focusing on identifying the primary contaminants as well as determining possible exposure pathways to the surrounding public. This initial phase will also consist of a technical review of the "Assessment of SRS Radiological Liquid and Airborne Contaminants and Pathways" developed by DOE-SR.

In the second phase, the ESOP will compare the DOE-SR critical pathway assessment to their current environmental monitoring program; evaluate the effectiveness of the DOE-SR environmental monitoring program and use of data in determining dose to the off-site population; and provide recommendations regarding improvements to both the ESOP and DOE-SR environmental monitoring programs. Once the second phase is completed, a project report will be prepared and made available to the public, DHEC employees, and other governmental agencies.